SCIENCE INFORMATION NOTES

A collection of articles on scientific and technological topics, research policies, science and society, higher learning, etc.

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Frontier Technologies and Their Role in the International Economic and Political System: - A Decade of Rapid Change

By Ward Morehouse

Technological Revolutions in the late 20th Century

It has become a commonplace to observe that we live in an era of rapid change. A look backward for even so short a period as a decade reveals just how rapid this change is in many fields of human endeavour.

Nowhere is this change more apparent in the realm of science and technology affairs than in the emergence of the so-called frontier technologies. Microelectronics, biotechnology, advanced renewable energy technology, ocean engineering, communications, space - the list will very. But whatever frontier technologies are included in such a list, certain characteristics apply in greater or lesser measure to these characteristics have important implications for the role of such technologies in the international economic and political system.

A decade ago there was little talk, in relation to rapidly changing advanced technologies, of "technological revolutions," even in the inflated rhetoric of public discourse about science and technology affairs. Now such references are frequent not only in journalistic and other public forms but also in more staid academic discourse.

Microelectronics is often referred to as the next (second, third, fourth - depending on how you count preceding ones) industrial revolution and the semiconductors, the principal hardware components of microelectronics, the "crude oil" of the 1980s. And another revolution in biotechnology, in the eyes of some observers, is not far behind.

What gives these frontier technologies a revolutionary character is the "spread effect" of their applications. It is essentially true of microelectronics and biotechnology, less so of some of the other frontier technologies mentioned above. Thus, microelectronics has applications that cut across almost the whole spectrum of productive activity in industrialised societies and in the so-called modern sectors of Third World economies.

Biotechnology - i.e., the application of knowledge based on modern bio-technology through genetic engineering, fermentation, and enzyme technology - will likewise have applications across a number of areas of economic activity, including virtually the entire agricultural sector, which is fundamental in all societies because it deals with the most immediate and basic human need of food with clothing and shelter following closely behind. But biotechnology is not confined to agriculture. It is going to have profound impact on a number of areas of industry as well, including food processing, pharmaceuticals, energy (both renewable and non-renewable), and chemicals.

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Another is their interrelated character. Indeed, control, monitoring, and other information handling systems based on microelectronics are vital elements in all the other frontier technologies mentioned above. Specific areas of rapid technological change are interconnected in other ways as well- for example, microelectronics and advanced renewable energy technology in photovoltaics use the same basic raw material (silicon).

An important implication of the interconnectedness of frontier technologies for the Third World is that it will be difficult to work at the leading edge of change in the technology internationally in a single field without being fairly far advanced in other, closely related or supporting fields. With far more limited resources, human and financial, for advanced work in science and technology, developing countries must pick and choose their priorities carefully. But if the goal is to be able to work at the frontiers of technological advance worldwide in a specific field, that goal may be next to unattainable without massive investments in bringing up the level of work within a particular country in a number of related or supporting fields.

Yet another significant characteristic of frontier technologies is that they are increasingly perceived by industrialised countries' governments as a major source of national economic power in the late 20th century. It took the Second World War and the application of scientific knowledge in such areas as guidance and detection of moving objects and nuclear fission to establish the vital importance of advanced science and technology as sources of political and military power and usher in, because governments realised there were important pay-offs, the era of "Big Science" and vast growth of government support of work in various fields of advanced science and related technologies.

To this powerful motivating force for government involvement in science and technology over the past four decades has now been added the increasing significance of commercial applications of the late 20th century frontier technologies such as those mentioned above, an awareness that economic survival, let alone prosperity, is heavily influenced by a country's capacity in these technologies. The stakes have thus increased enormously, and since the resources of industralised country governments, particularly large industralised countries, are far, far greater than even the largest and most advanced Third World countries, the Third World is again at a disadvantage.

However, Third World countries also have some offsetting advantages, and while the odds are difficult, a posture of despair leading to total inaction would be a certain course to the continuing and growing domination of the industralised countries in areas of advanced technology through the end of this century and well into the next.

One source of pessimism in Third World countries is the highly skewed global distribution of problem-solving skills in advanced science and technology and the much-touted gap between the First and Second Worlds on the one hand and the Third World on the other.

The Science and Technology Gap - Simultaneously Narrowing and Widening

While we lack comparable time series data and global statistics on science and technology should be used with much caution because of widely varying national definitions and categories, it does in general appear that the Third World is very slowly narrowing the gap in expenditure on R&D across all fields of science and technology. If the Sussex Science Policy Research Unit survey of world R&D in the early 1960s can be compared with Jan Annerstedt's OECD-sponsored survey a decade later (and there are important differences between them), they suggest that Third World spending on R&D grew during that decade from something like 2 per cent of the world total to perhaps as much as 3 per cent - obviously a tiny percentage of the whole but still a growing one.

More important, however, are the shifts in proportions of R&D personnel. During that decade (1963-1973), it appears that Third World personnel grew as a percentage of the world total from something like 3 per cent to around 12 per cent. And an examination of national-level data on scientific and technical personnel in major Third World countries like Brazil, India, and China does suggest that their pools of trained manpower are growing considerably more rapidly than the industrialised countries.

Thus, if that trend is maintained to the end of this century, it seems not at all unreasonable that the Third World countries will have as much as one-quarter to one-third of the world's R&D personnel, and perhaps total stocks of scientific and technical manpower as well. While this is far from a level proportionate to the Third World population in relation to the world as a whole, it does suggest that in distribution of personnel with advanced problem-solving skills in science and technology, achieving a goal comparable to the UNIDO objective of developing countries having 25 per cent of the world's manufacturing capacity by the year 2000 is by no means out of the question.

Nonetheless, in areas of advanced technological development, the Third World has far to go, and it is quite likely that, with the sub-minimal efforts being made in most developing countries, the Third World is falling behind and the gap is actually widening. Consider the case of microelectronics. While this is not all that is spent in India, the Government of India Department of Electronics R&D budget of approximately Rs 7 crores ($ 7 million) in 1982-83 (across all phases of electronics, although much of it would be focused on more advanced areas of technology appropriately labelled microelectronics) is an indicator of a

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rough order of magnitude of effort. Contrast this with what a single corporation in the industralised world, albeit by far the largest in computers and related technology, IBM spends on its R&D - namely, $2,037 million or about Rs 2,037 crores in 1982.

Such direct comparisons of R&D expenditure on frontier technologies, while they do indicate an approximate level of effort, are nonetheless misleading to a degree. While some costs are higher and some lower, in general research costs less in the Third World than it does in the industralised countries. And as the personnel base in scientists and technologies with advanced training increases in the Third World, developing countries will have a substantial comparative advantage in the conduct of research on frontier technologies over the industralised countries.

Third World Strategies and Industralised Country Reality in the Coming Decade

It seems unlikely that, with the long lead the industralised countries have in microelectronics that the Third World will in the foreseeable future be able to mount a substantial effort working at the leading edge of the technology internationally, let alone overtake the industralised countries. But in another area of frontier technology not nearly so far advanced in terms of its commercial and other applications - namely, biotechnology - the picture could be different a decade from now if those few Third World countries with a sufficient concentration of scientists and technologists in fields related to biotechnology such as Brazil and India were to begin now to implement vigorous national strategies of development in biotechnology.

In fashioning such strategies, however, Third World countries need to factor into their calculations changes which are occurring in the domestic political economies of industralised countries. Reflexive rhetoric about the need for a New International Economic Order by Third World political leaders, no matter how just they think their cause is, will not bring about significant changes in distribution of power within the international system.

Take, for example, the persisting lament of Third World governments about the need for more access on better terms to industralised country markets, especially for manufactured goods. Then consider the economic and political realities within industralised countries - realities which are being shaped in part by the development and application of frontier technologies, perhaps especially microelectronics.

The technological displacement of labour as a consequence of the application of these technologies is an important factor in the growing structural unemployment in industralised economics. It is native in the extreme to expect developing countries to have more access to industralised country markets when unemployment appears stuck at 10 or 12 per cent

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in many industralised countries. (The true unemployment in most of these countries is substantially larger since in general "discouraged" workers who have given up even looking for a job - a growing phenomenon as rapid technological change makes whole categories of work obsolete - are not included in these figures.)

Given the political realities within industralised countries in such circumstances, not only there is not going to be any greater access but the chances are that what access there now is may be increasingly restricted as irresistible pressures for protection rise within industralised country political economies. This in turn means that export-led strategies of national development in the Third World are fraught with peril in the 1980s and 1990s, at least to the degree that they bank on increased access to industralised country markets.

Frontier Technologies and the Debt Trap

Yet another important phenomenon in industralised country political economies is that in a number of areas of manufacturing and even some services, markets are reaching, within these countries, the saturation level. When that happens, there will be growing pressures on industralised country governments by large corporations to increase financial support for exports of such products and services to the Third World as a means of maintaining production levels in these industries in the developed countries.

Although the net effect of such an arrangement is to bring about a transfer payment (out of general tax revenues provided by all citizens) to specific industries in the industralised countries, Third World countries are likely to end up footing a good deal of the bill. The subsidies for these exports will probably come primarily as loans, thereby increasing Third World external indebtedness and perpetuating their dependent role in the international economic and political system.

Those who think this is a fanciful scenario should ponder India's experience in recent months. More and more, especially in the industrial capital goods sector, Indian companies are losing major contracts within India to industralised country competitors which, through tied aid credits, are able to make offers too attrative for the Indian customer (usually a government body or a public sector company) to refuse. No one knows the magnitude of this displacement, and it would be difficult under the best of circumstances to measure comprehensively. But some observers of the Indian industrial scene believe that it is widespread.

The inhibiting consequences of such indebtedness may well in time have an adverse effect on Third World efforts to develop major strengths in some areas of frontier technology, particularly if these efforts are

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perceived as threatening Northern domination of key markets for products and services based on such technologies. No one should for a moment assume that, when the U.S. government came to Brazil's rescue in rescheduling its external debt, a quid pro quo was not exacted.

It may well never have been made explicit, but once a Third World country is locked into such a highly compromised and vulnerable relationship to a major industralised country, it is inevitable that the Third World country will be more restrained in its international actions. While the level of effort in Brazil is far from the stage where this could occur now, a scenario five years from now in which the Brazilian government would be quietly informed by the U.S. government responding to pressures from large corporations with major stakes in specific aspects of biotechnology, that the Brarilian government should diminish the magnitude of its support for development of these technologies in Brazil is not inconceivable.

First World National Security and Third World Access to Frontier Technologies

Yet another type of scenario involves increasing access to advanced technologies by developing countries on the grounds that the national security of the industralised countries may be compromised. Indeed, the U.S. government already has such legislation in the books in the form of the Export Administration Act, and the current U.S. Administration is in the process of tightening restrictions on the export of "militarily significant" technology. While the original purpose of the Act was to limit access of Soviet Bloc countries to U.S. military technology, it appears likely that the scope of the Act will be broadened in such a way as to try to encourage sales of the products of advanced technology from the U.S. without giving other countries access to the technology necessary for making these products themselves. Beyond that, Third World countries are specific target of the new restrictions because they are regarded as conduits for re-export of such technology to the Soviet Bloc.

A good illustration of how the real world functions in such circumstances was provided to me by an international expert on the semiconductor industry (himself from another Third World country but working in a First World institution) who served as a consultant to the Government of India in exploring the possibility of India's making an equity investment in a U.S. semiconductor company in order to gain access to that technology. Informal approaches were made to the U.S. State Department to determine whether the U.S. government would permit an investment, and the reported response was that, while such an investment might be permitted in the case of two other Third World countries which were also exploring a similar strategy - namely Mexico and Brazil - it definitely would not in the case of India.

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And even in the Brazilian and Mexican situations, it was indicated that actual transfer of technology would be subject to review on a case-by case basis. (Mexico, of course, is another Third World country recently bailed out by the U.S. government when it became overextended with its foreign debt.

Given all of these circumstances, what are the alternative available to Third World countries in developing meaningful and effective national strategies in frontier technologies. It must be recognised at the outset that there are no easy panaceas or "best" approaches. The search rather must be for "least worst" strategies.

Technological Intelligence and Developing Country Options

Whatever else a developing country does, the very first thing it must do is to strengthen substantially its efforts to gather, analyse, and use technological intelligence directly related to its own national needs and objectives. Intelligence, it should be remembered, is simply information purposely collected, analysed, and used in specific action situations. Third World adversaries and negotiating parties such as industralised country governments and multinational corporations make extensive efforts to collect and analyse intelligence on Third World countries; Third World countries can do no less.

The vast proportion of intelligence of this kind comes from entirely open sources. In the frontier technologies, while there certainly are some areas of proprietary knowledge zealously protected by those who have that knowledge, much, much more intelligence about frontier technologies is in the public domain or can be secured quite legitimately through the use of consultants and firms that collect, analyse, and sell business information. Furthermore, substantial amounts of information must be revealed in filings for patents in industralised countries, so that substantial intelligence can be gathered simply by a careful monitoring of patent applications in those countries.

Beyond that obvious first step, there are a number of additional steps and guidelines for action which can be taken by Third World countries to cope with and try to contain, if not exploit, frontier technologies. Here are seven suggestions advanced by an internationally recognised Third World scientist working in one of the scientific areas on which frontier technologies are based.

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1. Every developing country should make specific development decisions and technological choices entirely on its own. Where needed, it may seek advice from abroad, which should come, as far as possible, from individual scientists and technologists or non-governmental research institutions rather than foreign governments. Similarly, if the country decides it needs to obtain scientific or technological expertise from outside, it should as far as possible make the contacts directly rather than through other governments. The country should then, where necessary, pay those experts directly preferably with its own funds but if not with funds from other sources such as international organisations.

2. Where local expertise does not exist in areas delineated by the country as necessary to its development goals and strategies, it should send its nationals for experience or training in a suitable institution abroad insofar as possible through direct negotiations with the institution rather than through a government, whether this institution be a university, research laboratory, or industrial enterprise.

3. Developing countries should make a special effort to get to know each other's strong points. All other things being equal, assistance from one developing country to another is less likely to be exploitative than assistance from an industralised country government (even with the best of intentions of the individual industrialised country scientist or technologist) to a developing country.

4. If a developing country decides that it is serious about trying to master some aspect of a frontier technology, it must be prepared to allocate adequate funds for investment in scientific and technological efforts within the country and for its scientists and technologists to visit other countries, developed or developing, for a specific purpose that would directly aid the development of that particular scientific and technological capability within the country.

5. Any financial assistance from an outside organization or foreign government should be in the form of a block grant to which the developing country should add its own resources for futher allocation as it considers necessary. Tied or categorical aid usually turns out to be no aid at all but only a means of perpetuating dependence.

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6. A developing country should not go in for technology in an area unless there is a strong base of science within that area in the country. This applies especially to the import of technology. Technological exploitation of one country by another is much less likely to occur when there is a strong scientific base within the developing country with which to evaluate the technology being offered from outside.

7. If a developing country is going to make a commitment to developing a strong scientific base in a frontier technology area, the quality of that base must be judged by international, not parochial or local standards.

Larger and industrially and scientifically more advanced Third World countries should seek to develop explicit national strategies in key areas of frontier technology. As an illustration, a beginning has been made in India with the establishment of a relatively high-level coordinating body in the National Biotechnology Board and with active support from the top level political leadership in the country. But this is only a beginning. Along with strengthening the institutional base for R&D in biotechnology, it is vitally important to link that institutional base to productive activity, perhaps through the medium of public sector corporations with ten-year characters to translate research into production in such key areas as genetic engineering, immunology, enzyme technology, photo-synthesis, alcohol, and tissue culture.

Options for smaller, much less advanced Third World countries in relation to frontier technologies are obviously more limited but still not existent. These countries lack even the most basic scientific and technological expertise of their own for identifying and analysing, let alone dealing with, the consequences of rapid technological change elsewhere in the world. But because their economies are smaller, more often based on one or two key primary commodity exports, and therefore more vulnerable, the need for them to have the capacity to respond to such changes is all the greater than the larger and more advanced developing countries. The export base in the least developed economies can be destroyed with one major breakthrough in, say, biotechnology resulting in the manufacture within industralised countries of a lower cost synthetic substitute for one of their principal exports.

If all of the rhetoric at international conferences and in U.N. documents and reports is to be taken at even a mere fraction of its face value, the international community has a special role to play. Because, unfortunately, the track record of that community over the last 30 years is none too good in resisting the temptation to exploit or manipulate these weaker, more dependent actors in the international system, the more alternative sources of help available to the least developed countries the better.

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The more skilled among these countries will be able to play different sources off against one another, whether they be industralised market economy countries, industralised planned economy countries, the more advanced Third World countries, or the U.N. system. Certainly the most immediate need, as has been suggested, is to help these countries acquire technological intelligence gathering and bargaining skills and independent and preferably multiple sources of technical advice adhering as closely as possible to the criteria set forth above on suggestions for action for developing countries.

Frontier Technologies and Development Strategies in the Decade Ahead

The decade past has thus been characterised by the rapid emergence of frontier technologies with their accompanying "revolutions" in the North that have challenging, if not ominous, implications in the South. In the process, the role played by science and technology in the global political economy has begun to change qualitatively, compelling developing countries to recast their options for the decade ahead. While those options are obviously going to be different for the industrially more advanced developing countries than for the least developed countries, all are going to be affected.

Whatever specific options related to frontier technologies are pursued, all developing countries - both the industrially more advanced and the least developed - would do well in formulating their overall national development strategies, to consider the warning of the doyen of development economists, West Indian Nobel Laureate W. Arthur Lewis. He urges them to resist the siren song of the industrialised North and from international agencies reflecting Northern views of the future of the world economy that the only road to economic salvation is through export-led growth. This is a questionable advice, when future prospects for those countries exports to the industrialised North lie increasingly in the hands of Northern industrial research laboratories.

The fact is, Lewis suggests in offering an alternative scenario for the South, that:

> ...the LDCs should not have to be producing primarily for developed country markets. In the first place, they could trade more with each other, and be less dependent on the developed countries for trade. The LDCs have within themselves all that is required for growth. They have surpluses of fuel and of the principal minerals. They have enough land to feed themselves, if they cultivate it properly. They are capable of learning the skills of manufacturing, and saving the capital required for modernization. Their development does not in the long run depend on the existence of the developed countries, and their potential for growth would be unaffected if all the developed countries were to sink under the sea.

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No one would suggest, however, that the Third World can do without access to the First and Second World in the development of frontier technologies. But what is clear is that Third World countries must fashion their own strategies not on native expectations of the benign application of these technologies to their problems as long as these technologies are effectively controlled by the industrialised countries. Rather, it depends upon their ability to fashion initatives that talke into account the realities of the international economic and political system and the impact which these technologies have had on that system over the past decade and are likely to have in the next.

But even if developing countries are able to devise "least worst" strategies for containing the adverse impact of frontier technologies on their position in the global political economy, there is little cause for celebration in terms of the likely consequences of widespread dissemination and application of these technologies for the poor and oppressed. For the experience of the past 30 years has demonstrated all too often the perverse impact of technological change on social justice.

The "refraction effect" exerted on technological interventions in poor peoples' lives- through which the benefits tend to be distributed in approximate proportion to the existing distribution of assets and power in society- bodes ill for the exploited and powerless, not only in the Third World but in all societies, whatever their level of development. The goal of building a more just and equitable social order is likely to remain as elusive in the coming decade dominated by late 20th century technological revolutions as in the past decade characterised by the emergence of these revolutions.

(Philosophy and Social Action, X(1-2) 1984, pp.27-37)

Recent Development in Cardiology

By Tsung-O Cheng

Many new advances in cardiology, both diagnostic and therapeutic, took place during the last decade, some through accelerated successful technologic innovations, e.g. two-dimensional echocardiography and radionuclide cardiac imaging, and some through the introduction of new and promising pharmacologic agents, e.g. nifedipine and verapamil in the treatment of coronary artery spasm. Also researches on old diseases e.g. coronary artery spasm and mitral valve prolapse, as well as clinical application of new procedures, e.g. percutaneous transluminal coronary angioplasty and dynamic spatial reconstructor have contributed much in this aspect.

ECHOCARDIOGRAPHY

While M-mode echocardiography has become an accepted method for detecting noninvasively pericardial effusion, asymmetric septal hypertrophy, mitral stenosis and atrial myxoma, two-dimensional echocardiography adds a new dimension to this method of cardiac diagnostic technology. Providing a one-dimensional ("icepick") view of the heart, M-mode echocardiography displays the cardiac structures in an unfamiliar format that do not resemble the actual configuration of the heart, and therefore requires the use of a deductive approach and relies heavily on one's ability to integrate echocardiographic data into a mental anatomical image. On the other hand two-dimensional echocardiography is capable of visualizing a larger portion of the heart in its correct spatial orientation in real time and displaying anatomical data in a form that all physicians are familiar with.

Currently there are three technics of real-time two-dimensional echocardiography, mechanical sector scanner, multi-element linear array scanner and electronic sector scanner or phased-array system. The mechanical sector scanner consists of a single crystal transducer that is made to oscillate rapidly by means of an electric motor through a 30^{o} to 60^{o} arc. The advantage of this system is that it is relatively inexpensive and provides good quality images, and with it many M-mode units can be adopted for two-dimensional scanning. Its disadvantages are a narrow angle, noise and a vibrating sensation, occasionally irritating to the patient. More recently, to overcome some of these limitations wide-angle (80^{o} to 90^{o}) mechanical sector scanners utilizing multiple rotating crystals have been developed.

With multi-element linear array scanner, the transducer comprises 20 separate linearly arrayed crystals. Each crystal is pulsed rapidly and sequentially and the image is displayed as a series of single line reflections. The large transducer size, low line density and wide beam size result in overall poor resolution and discontinuity of images from the underlying ribs. This system seems to perform better in children in whom the depth of the area of interest is shallow and the ribs are mostly cartilaginous.

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Electronic steering of the ultrasonic beam by phased element excitation through an arc up to 90° has been the most recent development in the two-dimensional echocardiography. Instantaneous and continuous pictures of the beating heart with high resolution can be obtained with a small stationary transducer by the use of high speed electronic sector scanning as is utilized in radar technology.

Two-dimensional echocardiography is superior to M-mode echocardiography in: mitral or aortic stenosis in directly assessing of severity by depicting valve immobility and measuring the actual orifice; infective endocarditis in localizing the vavular vegetation and depicting its size, shape and motion characteristics; congenital cardiac defects in identifying the interrelationships of cardiac structures with greater certainty, with or without contrast material; mitral and/or tricuspid valve prolapse in avoiding overdiagnosis or underdiagnosis using a single echobeam; right heart disease in yielding complete and useful data, especially with contrast material; asymmetric septal hypertrophy by integrating a great many measurements, in giving better indication of the nature and severity of the disease; evaluation of ventricular function where two-dimensional echocardiogram in supplying an additional dimension, the long axis, thus yielding a more accurate volume calculation, as well as in demonstrating nonuniformity of ventricular shape and contraction; and study of posterior cardiac structure in identifying especially the descending thoracic aorta, as well as in detecting and following localized or diffuse aortic aneurysm.

Nuclear Cardiac Imaging

While the 1960's saw the development of coronary arteriography and refinement in technic and equipment that have increased the diagnostic capabilities and patient safety of this important radiographic procedure, it was the introduction of various myocardial imaging technics in the 1970's that has widened the horizon of noninvasive diagnostic cardiology. While cardiac angiography uses radiopaque iodinated agents to delineate the inside of the cardiovascular system by making the latter appear significantly denser to X-rays than surrounding tissue, in nuclear cardiology an image is generated by injecting the patient intravenously with a tracer dose of radionuclide.

There are two general categories of nuclear cardiologic approaches. One deals with studies of cardiac function and performance for which a radionuclide, usually technetium-99m, is used that remains within the intravascular space during the period of study. This period of study can be as short as 10-30 seconds if a first pass radionuclide angiocardiogram is performed or 10-20 minutes if a multiple ECG-gated equilibrium cardiac blood pool (MUGA) study is done. The second involves evaluation of myocardial perfusion and viability for which radionuclides are utilized that accumulate intracellularly. These radionuclides may accumulate maximally in normal myocardium as is the case with thallium-201 or in infarcted myocardium as with technetium-99m pyrophosphate. In contrast to thallium which shows the zone of abnormality as a zone of decreased myocardial perfusion or a "cold spot",

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pyrophosphate which defines a myocardial infarct as a zone of increased radioactivity is a "hot spot" agent.

Thallium imaging combined with exercise can further differentiate myocardial ischemia and myocardial infarction. In a normal healthy person the distribution of thallium appears relatively homogeneous throughout the left ventricular myocardium. In patients with coronary artery disease areas of diminished activity seen on the exercise images, but not on the redistribution or rest images, indicate regional ischemia. Defects seen at rest or defects that persist on delayed images suggest mycardial infarction.

MUGA and first pass imaging may also be combined with exercise in patients with coronary artery disease or valvular heart disease. Normal subjects will increase their ejection fraction with exercise. Patients with coronary artery disease and exercise-induced ischemia will frequently exhibit a decrease in ejection fraction and new regional wall-motion abnormalities. Borer et al also showed that in patients with aortic regurgitation, radionuclide cineangiography may detect abnormalities in left ventricular function during exercise, even in asymptomatic patients and thus serial studies by this noninvasive technic may help decide the optimal time for aortic valve replacement.

Nuclear imaging and coronary anteriography are complementary to, not exclusive of, each other. Simply visulazing and estimating the degree of coronary arterial obstruction by arteriography does not show what effect the obstruction may have on coronary blood flow especially during stress. What is seen on the thallium images is in some ways more informative than on a coronary arteriogram, as what we are noting is the effect of ischemia, not the cause. Thallium imaging can help predict whether there is viable myocardium in the bed supplied by obstructed vessel and approximately the amount that is jeopardized. Angiography offers an anatomic picture of the heart, while thallium myocardial imaging a pathophysiologic picture of it. Together they provide a more complete picture of the extent and significance of coronary artery disease.

Serial radionuclide evaluation due to its noninvasiveness is also helpful in evaluating left ventricular function in patients on drugs with potential cardiotoxicity, such as doxorubicin. Recently a joint study by the Fuwai Hospital, Chinese Academy of Medical Sciences and the Johns Hopkins Medical Institutions, Baltimore demonstrated that serial studies using a cardiac probe called "nuclear stethoscope" and indium-113m can be employed effectively to evaluate the left ventricular response to various Chinese traditional herbal medicine. One of the advantages of Chinese herbal medicines is that they are not as potent as Western drugs and thus have fewer side effects. But until recently it was difficult to ascertain if and how these herbal drugs work. Modern technology as exemplified by the "nuclear stethoscope" now makes this possible. It is a true representation of close integration between the traditional Chinese and Western medicine.

Coronary Artery Spasm

In 1959 Prinzmetal and Kennamer in their study described patients with angina at rest associated with ST segment elevation and postulated "increased tonus" of a Coronary artery or spasm. It, however, was looked

upon as an interesting rarity of not much clinical significance until early 1970's when bypass surgery for focal coronary artery obstruction became popularized and patients with Prinzmetal's angina were found to have focal single vessel obstructions and thus be ideal candidates for surgery. This close clinical-angiographic correlation was soon challenged by finding normal coronary arteriograms among patients with variant angina. Therefore, it is apparent that coronary artery spasm may develop either in the presence or absence of coronary atherosclerosis. It usually occurs at rest, although it has also been reported during exercise. Severe coronary spasm with no or minimal organic disease is one end of a continuous spectrum in which spasm superimposed on serere organic obstruction is the other extreme. Pronounced coronary vasospasm has been implicated in at least seven syndromes: Prinzmetal's variant agina, angina at rest, classic angina, preinfaraction angina, myocardial infarction, sudden death and a syndrome related to withdrawal from chronic exposure to industrial nitroglycerin ("Monday morning angina").

Diagnosis of coronary spasm by ECG or arteriography had previously been a hit-and-miss affair. It is usually not easy to record an ECG during an attack of coronary spasm because of its unpredictability. Physicians have employed various strategies to record the crucial ECG, e.g., admitting patients to coronary care unit for observation, giving them Holter monitoring or subjecting them to early morning exercise testing. Still there is no telling when and where an attack may occur. Periods of multiple daily episodes may be followed inexplicably by weeks, months, or years without attacks. Coronary arteriograms taken between attacks are of little use, since they may be entirely normal or do not demonstrate disease critical enough to account for the patient's symptoms.

However, recently, a provocative agent, ergonovine maleate, has been found which promises to do for most patients with variant angina what the exercise test has done for those with classic angina, namely, providing physicians with a reliable means of provoking an attack under carefully controlled conditions.

Although the problem of diagnosis seemed to have been solved by the introduction of ergonovine test, treatment of coronary spasm has frequently been a frustrating experience because surgical result is usually unpredicatable and many patients do not medically respond adequately to nitrate vasodilators in maximum tolerated doses. Recently a group of new coronary vasodilators, called calcium flux inhibitors, represented by nifedipone, diltiazem, perhexiline and verapamil, have shown great promises in the treatment of Prinzmetal's variant angina and preventing coronary spasm.

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Since patelet aggragation releases thromboxane A_2 which is a potent stimulus to coronary arterial smooth muscle contraction, antiplatelet agents such as aspirin, dipyridamole, sulfinpyrazone and propranolol have been tried to reduce coronary spasm. Theoretically antiplatelet drugs should be quite useful in patients with coronary spasm. However, some investigators have suggested that since aspirin and sulfinpyrazone block the conversion of arachidonic acid to cyclic endoperoxides, generation of thromboxane A_2 as well as synthesis of prostaglandin I_2 which is a vascular smooth muscle relaxant may account for the absence of dramatic therapeutic result. On the other hand, other investigators have proposed that since prostaglandin I_2 is formed in the vascular lining, the coronary arteries with severe atherosclerosis may be incapable of prostaglandin I_2 synthesis and thus these agents may block only thromboxane A_2 generation with possible beneficial effects. However, since coronary spasm frequently occurs in normal coronary arteries or coronary arteries with minimal atherosclerosis, this hypothesis may not apply. Therefore at present the role of antiplatelet agents in the treatment of coronary spasm is uncertain.

It is apparent that we are at the threshold of a new and exciting phase in the understanding and management of coronary artery disease, brought about by the renewed interest in coronary spasm. In the wide spectrum of ischemic heart disease, where angina extends from the purely vasospastic form found in some cases of Prinzmetal's angina with angiographically normal vessel to the purely obstructive form caused by fixed atherosclerotic plaques, there lies an array of intermediate types with varying mixtures of vasospastic and atherosclerotic components. There is little that physicians can do medically to affect the fixed lesions of atherosclerosis, surgically they can, of course, bypass them. But a whole new panorama of medical therapeutic possibilities now exist for patients with preeminent vasospasm or in those in whom angina is accompanied by a fixed and a dynamic component either spasm or some other functional factor such as platelet aggregation. This new avenue may also prove rewarding in combating myocardial infarction, reducing infarct size, and preventing sudden death.

Mitral Valve Prolapse

The medical pendulum has swung more than once in the last two decades with respect to mitral valve prolapse. For the first half of the century the syndrome of midsystolic click was thought to be extracardiac in origin. In the early 1960's Barlow showed by left ventriculography that the click murmur syndrome was due to systolic prolapse of a floppy mitral valve. Subsequent workers reported several complications associated with mitral valve prolapse including severe mitral regurgitation, infective endocarditis, life-threatening arrhythmias and even sudden death. So the syndrome began to assume a more ominous character till the early 1970s when several investigators reported the rather frequent occurrence of mitral valve prolapse in normal population to be 6.3-17%. This author noted in a prospective study an incidence of 15.4% among 313 young healthy females undergoing routine physical examination. Thus the pendulum swang back again to a more benign nature.

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The entity, however, continues to be the center of attraction to the practicing cardiologists, because it is a great mimic of coronary artery disease and sometimes valvular heart disease. Patients with mitral valve prolapse often have chest pain and ECG changes indistinguishable from angina in coronary artery disease. As a matter of fact many patients have been diagnosed as having coronary artery disease either on clinical ground or on the basis of abnormal electrocardiogram. In the latter case the presence or absence of coronary artery disease can be demonstrated by coronary arteriography. Furthermore there are also characteristic ventriculographic features that distinguish idiopathic mitral valve prolapse from that associated with coronary artery disease. In the idiopathic variety the prolapsing mitral valve has the appearance of a bird's beak due to valve tissue redundancy, whereas in mitral prolapse secondary to coronary artery disease, the valvar protrusion is more like a nipple because of the associated papillary muscle dysfunction. Fortunately differentiation is now usually possible as a consequence of several clinical-angiographic studies, or by means of thallium exercise test.

Mitral valve prolapse may not only manifest as a systolic click but also a diastolic click. In the latter case it may be misdiagnosed as an opening snap and consequently mitral stenosis. On the other hand mitral valve prolapse may be associated with mitral stenosis. This unusual combination poses a diagnostic challenge, but echocardiographic examination is uniquely suited for diagnosis of both conditions in the same patient.

Percutaneous Transluminal Coronary Angioplasty

Cardiovascular catheterization has progressed from being a more diagnostic tool in the early 1950's to a practical therapeutic device in the late 1970's. Following successful nonsurgical intravascular retrieval of retained intracardiac catheters, transcatheter arterial vasopressin infusion or embolization for control of acute gastrointestinal or genitourinary bleeding, intraarterial embolization of cerebral arteriovenous malformation to prevent intracranial hemorrhage, nonsurgical closure of patent ductus arteriosus and atrial septal defect, the most recently introduced 'therapeutic' cardiac catheterization is percutaneous transluminal coronary angioplasty. This technic, in the words of its inventor, "has the advantage of providing instantaneous (myocardial) revascularization without the need for open heart surgery".

This procedure extends previous advances in the diagnosis and therapy of coronary artery disease. 20 years ago Sones and Shirey achieved a major advance in diagnostic cardiology introducing selective coronary arteriography. This procedure permitted precise localization of a coronary artery obstruction and provided the basis for the development of coronary artery bypass operation. In the early 1960's Dotter and Judkins introduced the concept of dilating an atherosclerotic obstruction in a peripheral artery by means of an intraluminal catheter. In 1974 Gruntzig and Hopff used a double lumen

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dilatation catheter with a nonelastic balloon, modified on the basis of Dotter and Judkins' technic, to treat ilio-femoro-popliteal arterial obstruction and renal artery stenosis. Encouraged by their success in dilating lesions in peripheral arteries, Gruntzig and associates developed a smaller version of the dilatation catheter to treat coronary artery obstruction. It was estimated that by July 1979 this procedure had been attempted in 259 patients throughout the world with a success rate of 56%. It appears to be a promising procedure in a selected group of patients with coronary artery disease estimated to be less than 5%. In the spring of 1979 the National Heart, Lung and Blood Institute started a preliminary Interim Registry on Percutaneous Transluminal Coronary Angioplasty to facilitate evaluation of this technic. Only through carefully conducted and evaluated clinical studies will the true value of this promising new technic be fully clarified and its ultimate role in treatment of coronary artery disease defined.

Dynamic Spatial Reconstructor

The most sophisticated, technically complicated, and exciting research achievement in cardiology of the past decade is the Dynamic Spatial Reconstructor (DSR) for short. It is a new generation X-ray computerized tomography (CT) scanner designed by Wood and his colleagues at the Mayo Clinic.

Conventional tomography is a diagnostic technique that blurs the images in front of and behind the area which the examiner wishes to concentrate on. By typing tomography to a computer, the operator is able to get a cross section of the area to be examined. This approach eliminates blurring and thereby greatly improves the quality of images.

In the time it takes the average CT scanner to produce a single cross section (about five seconds), the DSR can offer its user 75,000 cross sections. The DSR is able to mathematically dice the body. Then, by reconstructing these cubes electronically, the Mayo investigators are able to "call up" and recombine these cubes so as to produce moving, three-dimensional X-ray images of any organ within the body, for example, the heart. The new type of X-ray image will show the heart life-size and in motion, as though the body had been rendered transparent. It can then be sliced up at any desired angle needed to reveal or exclude the disease in question.

The DSR could revolutionize the practice of cardiology and, for the matter, of medicine. It will provide important new physiologic insight into the functions of the beating heart within the living human body. It will do all this without causing the patient any pain or discomfort and with less ionizing radiation than in many diagnostic radiographic procedures.

(Chinese Medical Journal, 96, 7(1983) pp.499-506)

The Pursuit of True Scientific Inquiry
- Thoughts from the Conference on Life Sciences and Mankind -

By Setsuro Ebashi

Fears of Restricted Discussions

Present-day Japanese society has been highlighting only the potential benefits and dangers of the new field of life sciences, and ignoring the actual efforts being made in research. In other words, Japanese society takes notice of only those aspects of the life sciences with which it comes into contact, such as the applications for industry or the potential for creating "blasphemous" new life forms. An unfavorable environment thus exists for scientists who are engaged in painstaking research in this new field for the interest of increasing man's body of knowledge.

Therefore, I must confess that I felt somewhat apprehensive when I first heard that Japan was to be the host for the first Conference on Life Sciences and Mankind. The scientific tradition in Japan is short in comparison with that in the West. Consequently, support in the society for researchers in pure science is still weak. I feared that the participants in the conference would feel self-conscious about expressing their ideas and findings in an environment stirred up by the mass media's fantastic conjectures.

My fears, however, proved to be unjustified. The conference was a success, primarily because the foreign participants, which included philosophers, moralists and theologians, possessed extensive experience in dealing with this controversial subject. All of the participants presented coherent arguments, and acknowledged the validity of differing views.

Another fear I had concerning the conference was that the participants, including myself, would be constrained in expressing personal views since the conference had been initiated by the Japanese government. But these concerns as well proved to be ungrounded since the government took great care in assuming an inconspicuous role. In addition, the scholars and intellectuals at the conference were guaranteed the freedom of expression because they were not acting as representative of their governments. This guarantee was crucial because the conference could be significant only if there were a free exchange of information and opinions. In this respect, the conference served as a valuable precedent.

The conference was a success in that it also fulfilled its objective of providing a forum for discussions to clarify the controversial issues concerning the life sciences. We were greatly aided in this respect by the French decision to host the next conference, since it

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allowed us to carry on our discussions without having to formulate any definitive conclusions.

Aggressive Search for A Larger Solution

One of the lessons from the conference for the Japanese was that we were forced to reconsider the meaning and purpose of science. Though they appear to be making great progress, the life sciences cannot advance in the long term unless there is an accumulation of wisdom gained from the other sciences. Moreover, true progress cannot be realized solely through abstract arguments and conjectures. Scientists must be aggressive in pursuing the goals of their research.

Too much emphasis on the normative control of science leads the general public to view scientific in quiry as something evil. Such an environment is dangerous since it stifles the vitality of scientists, and eventually of the society as a whole. Science is valuable for the welfare of mankind; even culture and philosophy cannot develop without scientific progress in the society.

One harmful trend in present scientific inquiry that needs to be corrected is the concentration of attention and effort into a single field. No field can progress solely by itself. Although scientists in Japan are currently engrossed with the development of recombinant DNA technology, they need to realize that other fields such as neurobiology hold much promise for the advancement of the biological sciences as a whole. Even as we can see from our own bodies, life is impossible with out the integration of a variety of physiological functions; biogenetics is just one part of a larger biological puzzle. Thus, the field of biogenetics should be developed in harmony with the other life sciences as well as with the interests of society Similarly, scientists in these other fields should view the problems arising in biogenetics as their own.

Equal Weight on Science and Technology

Science has two important aspects. The first is the elucidation of the causes of natural phenomena, as was demonstrated by scientists in Europe during the 16th-18th centuries. The second is the practical application of science and the integration of science with technology - an approach which developed from the European scientific tradition, particularly in the U.S. I disagree with the view that the former aspect serves as the elementary stage of science, and the latter as a secondary, or more advanced, stage. For example, China developed technologies, such as printing, long before they appeared in the West,

but failed to analyze the science behind these technologies in the typical Western scientific tradition. One reason is that the Chinese valued technology only for its practical applications, and felt no need to examine the scientific principles underlying the technology. The Chinese case thus reveals clearly that neither aspect supersedes the other, and that both should be advanced in a balanced manner.

The Conference on Life Sciences and Mankind demonstrated the importance and value of a free exchange of views and findings for the advancement of science. At the very least, the participants recognized that they should pursue their research independently of prevailing hysterics in society. With the establishment of forums for free discussion, scientists will be able to form a broader perspective in their research, and thereby help to bring about a balanced, and ultimately ideal, development of science and technology.

(Look Japan, (10 May, 1984) p.5)

Japan Science and Technology White Paper 1983
Important Trends for an Informatized Society

By Akihiko Iwahashi

The White Paper examines the recent advance of information technology into all aspects of society. Part 1 of the White Paper analyzes the present status and future development of informatization in Japan from a scientific and technical standpoint. Future prospects for science and technology in relation to the increase in information are also presented. Parts 2 and 3, as in previous years, summarize trends in science and technology and government measures conducted during fiscal 1982.

The following is a summary of Part 1, entitled "Toward the New Development of Informatization."

An Informatized Society

After enjoying a decade of rapid economic growth in the 1960's, Japanese society and economy in the 1970's encountered various changes, such as an increased restriction of energy sources and heightened international trade frictions, as well as an emergence of new factors including the growth of services in the economy and changes in the industrial structure in response to a diversification of the people's needs and values.

These developments were seen not only in Japan but in many of the industrially advanced countries as well. One of the most significant changes was that the value of information expanded far more than did the value of material goods and resources in the society. The White Paper uses the term "informatization" to denote the structural changes in Japanese society arising from the spread of information.

A large majority of the Japanese people see the present-day society as being an "informatized" society. They feel that information already exerts considerable importance for everyday life, and believe that this importance will further increase in the future. There has also been a great change in attitudes towards computers. Although there is still some anxiety about the intrusion of computers into private life, their usefulness is being evaluated more highly than it was five years ago. Many individuals feel that the computer has become indispensable for modern life.

Informatization is rapidly advancing in the structure of employment as well. Although only 18% of all Japanse workers in 1960 had been engaged in the information field, in 1975 this figure reached 30% second only to the manufacturing industry.

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According to indices measuring the degree of informatization, which is comprehensively analysed through the volume of information, percentage of information equipment in use and various other factors, the figure for the United States in 1965 was 2.5 times higher than that for Japan, but this differential has narrowed to about 1.5 times in 1980 as a result of Japan's rising index. Moreover Japan's index already exceeds those for West Germany and the United Kingdom. One characteristic of Japanese informatisation is its focus on hardware such as computers and communications equipment.

Expansion of Informatization Into Industry

In the industrial sector, the expansion of computers and software has been accompanied by the implementation of automated control over production in the iron-steel and chemical industries, and the introduction in the iron-steel and chemical industries, and the introduction of NC machine tools, CAD/CAM and industrial robots in the processing and assembly industries. Informatization is presently progressing towards the automation of entire factories, with the development of the Flexible Manufacturing System (FMS) that will make possible unmanned factories. These developments, coupled with increases in productivity, have facilitated the production and rapid expansion of NC machine tools and industrial robots, such that Japan now stands as the world's leader in these fields.

The introduction of these machines can be justified by several reasons, such as their capabilities to enhance productivity and the production process and to ensure labor safety. Practically no enterprise has ever discharged its workers or called for voluntary retirement as a result of the introduction of these machines. Instead, through education and retraining, the workers are redistributed elsewhere in other enterprises or throughout the automated process.

At the same time, computers are being installed and replaced by newer models in the workplace so as to achieve rationalization and greater efficiency. Particularly since 1975, there has been a conspicuous expansion in office computers, personal computers and Japanese-language word processors, which has been supported by the development and improvement of software, including Japanese-language word processing. Use of data processing computers is also on the rise in the retail and warehouse industries.

Greater Efficiency And Convenience

As for information technology in the public sector, computers have long been utilized for making train reservations and for managing operations. Computers are also widely used for trafic control in the air, in ports and harbors, and on roads.

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In the field of medicine, steady progress is being made in the use of image diagnosis by X-ray CT and NMR-CT, as well as in the automatic analysis of electrocardiograms that will make diagnosis, nursing, etc. more precise and efficient. Development and utilization of the medical information system are also advancing.

Educational uses of information technology are expanding as well, as seen in recent preparations for the establishment of a University of the Air and experiments in Computer Assisted Instruction. Progress is also underway in the development of data bases for administrative information and for scientific and technological information.

Information technology is also bringing greater convenience, comfort and safety of services to private lifestyles with the availability of nationwide automatic telephone dialing services, electronically operated household appliances and on-line service by financial institutions.

In particular, the new two-way media forms, which have come into practical use in recent years, have been attracting much interest for their utility and suitability for the growing diversification of personal values and lifestyles.

Development in Information Technology

The elements used in computers and communications equipment have progressed from electron tubes, to transistors, and to integrated circuits. Active efforts are steadily being carried out in the research and development of new elements. With the realization of high integration, high speed and greater functions, IC's have been developed for microcomputers and other uses. New elements overcoming the limitations of the Si element have also been developed, such as the GaAs element, HEMT, and Josephson element.

Along with the technological progress in information elements, there has been an improvement in hardware, such as higher speed, larger capacity, lower costs, miniaturization and greater reliability.

With regard to software, significant expansion has been achieved in its functions, convenience and applications for use. In Japan, the development of software has lagged behind that of hardware. Software development is crucial for the improvement of basic software, such as operating systems, as well as for application software to enhance computer systems. But because the development of software is primarily carried out by humans, increases in productivity for this field have been low. There now is the need to raise productivity for the future.

Digitalization in communications technology is steadily advancing. As a result, development of a digital information and communications network has necessitated the establishment of a communications protocol.

At present, the scale of research and development for information technology is growing faster than the industry as a whole. Japan ranks second among the industrially advanced nations, following the United States, in the size of its research funds and the number of its researchers in this field.

The private sector accounts for an overwhelming share of Japanese research and development efforts. The communications and electronic machinery industries and various other enterprises are actively engaged in research and development for data processing. Cross-industry efforts have also emerged, and are expected to expand in the future.

Toward the New Development of Informatization

As described above, informatization is spreading through all sectors of society as a result of burgeoning scientific and technical developments. According to a survey of technological forecasts compiled by the Science and Technology Agency, many technical problems are expected to be solved by about the mid- 1990's. In addition, the following efforts in science and technology are considered important for the future development of informatization.

(1) Balanced development between hardware and software.

(2) Expansion of original research and development into basic fields; flexible and comprehensive research and development efforts without overly strict adherence to previous divisions between research fields.

(3) Advancement of informatization while giving full consideration to the protection of individual and business privacy, and to the preservation of harmony with societal interests and the characteristics of Japanese society.

(Look Japan (April 10, 1984) pp.16-17)

A controllable aspect of the information explosion?

By Virginia Trimble

The scientific information explosion needs no introduction. More journals are publishing more papers by more authors on ever-more specialized topics than ever before. And, at least within the major American journals of astronomy and astrophysics, there are now also more words per paper than ever before (Abt, H.A. publs astr. Soc. Pac. 93, 269; 1981). The rise in mean paper length started shortly after the Second World War, since when it has been monotonic and more than linear with time, with the result that a typical 1980 paper is nearly three times wordier than typical 1910 - 40 ones. A similar trend was recently identified in European and American astronomical letters journals (Harris, W.E. Publs astr. Soc. Pac.95, 989; 1983). Despite editors' avowed intent to favour short communications over long ones, the average letter is 30 per cent longer today than it was 10 years ago. The obvious questions are why, and can anything be done about it? Determining just how widespread the phenomenon is and how it correlates with other properties of the papers may suggest answers. To quantify the data, I use a words-in-mean-paper-index (WIMPI), whose charm is that it readily permits comparisons among disciplines, decades and nations. Investigations of the subject can easily be performed by anyone with access to a large library and a strong index finger (at least the latter should probably be your own).

A preliminary investigation of one English-language journal each of physics, mathematics and chemistry from the UK, the USA and Japan shows that the trend spotted by Abt and Harris is very widespread. For every journal examined, WIMPI was larger in 1980-83 than in 1950. Increases ranged from 13 to 115 per cent, with an unweighted average of 64 per cent. This drops to 43 per cent, however, if we set the Japanese baseline year at 1955, by which time the effects of the immediate post-war woodpulp shortage had largely disappeared.

The 13 per cent minimum value belongs to Monthly Notices of the Royal Astronomical Society and the 115 per cent maximum to Journal of the Mathematical Society of Japan. After renormalizing the Japanese data, Journal of the Chemical Society London, Journal of the American Chemical Society and the American astronomical journals tie at 82-85 per cent for the largest increases in WIMPI since World War II. Disciplinary and national averages for the per cent increases in words per paper during 1950-80 are: physics, 27; mathematics, 77; astronomy, 62; chemistry, 93; UK, 45; USA, 65; Japan 85 (but only 20 per cent since 1955). Every reader can surely find something in these numbers to support his most cherished preconceptions.

Among the letter sections and journals (most of which are not more than 20 years old in their present formats), 10 year increases in WIMPI range from 5 per cent (J. Am. Chem. Soc.) to 38 per cent (Bulletin of

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the Chemical Society of Japan) and 20 year increases from 40 per cent (Bull. Chem. Soc. Japan) to 170 per cent (Journal of Physics). The average values are 26 per cent over the past 10 years and 76 per cent over the past 20. Some of the changes closely parallel changes in editorial policy; for instance, the mean paper length in Physical Letters B rose from 3.6 pages in 1973, when the rule was "maximum length not to exceed three printed pages", to 4.6 pages in 1983 when it read "should normally not exceed".

The net result is a 1960-80 average increase of 76 per cent in WIMPI for the letters publications, compared to 29 per cent to their associated main journals. Such a trend persisting over half a century would give us 12,000 word 'letters', equivalent to about 12 pages of Nature (whose authors are currently expected to review even rather broad topics in no more than 6). The high prestige associated with getting one's work into many of the letter publications seemingly encourages authors to push constantly at the length limits so as to squeeze in contributions that should really be full papers.

The complete range of data shows several other trends, strongly suggestive of causality. UK paper lengths shrank (though not as much as total numbers of papers published) during the First World War and the Depression and rose slightly during World War II (while paper numbers, of course, dropped enormously). American paper lengths changed little during these periods. The reader will immediately think of a variety of explanations in terms of the kinds of people available to do scientific research and the resources available to them. For Physical Review and Proceedings of the Physical Society (=Journal of Physics) the 1980 WIMPIs have only just climbed back to the pre-war peaks reached in 1920 and 1930 respectively. Annals of Mathematics is unique in showing a continuous nearly-linear rise in WIMPI ever since the turn of the century. Its 1980 papers are, on average, 3.3 times the length of its 1900 ones, reflecting an increasing determination on the part of the editors to accept only papers that present a major new idea in full detail (Rector, D.L., personal communication).

The main trends - universal post-war WIMPI creep most heavily concentrated in letter publications, correlations with world economic and political events, responses to editorial policy, and differences among disciplines and nations in (perhaps) expected directions - are all strongly suggestive of an effect largely driven by forces external to the kind of scientific research being reported. This, in turn, provides some hope of moderating the current exponential literature growth. Unfortunately, the sociology of publishing is such that each author's doing what he perceives as best for himself is unlikely to lead to the best possible result for the scientific community as a whole. Perhaps the time has come for some sort of Social Contract among authors, editors, referees, readers and sponsoring agencies.

(Nature, 310, 5978(16 August, 1984) P, 542)

Science Is Universal - The Practitioners Are Not

By Norman Hackerman

It is commonplace in the community to approach the debate concerning the level of federal support of science and engineering by emphasizing the importance of research accomplishments. Lost to sight is the great contribution of the research universities in educating scientists and engineers. Usually attention is called to advances made or to shining goals perceived. This is intended to demonstrate the value of basic research in the United States, with the implicit understanding that the major portion of public funds will be used at universities.

The argument is made that the yield of research from educational institutions has been important to the nation and that the continuation of the process is necessary. The system has indeed worked well, and the basic knowledge of nature so developed has been vital in the sequence of science to technology to ultimate use. Unfortunately, the science and engineering communities are finding shortfalls not only in their minimal annual expectations but also in the now widely accepted belief that there is extensive deterioration of the necessary supporting infrastructure - that is, facilities, equipment, and their support.

With all these accumulated problems it is surprising that the principal reason for continuing with the arrangement that we use in this country is either left out of the argument or, at best, used only as secondary item. It is not recognized that although science is universal, scientists and engineers are a national resource.

The world requires technology of an ever higher order just to maintain itself, and the country requires the highest order of technology to maintain its leading position. It follows that the availability of a sufficient number of educated, high-quality scientists and engineers is crucial. Thus, the main reason for the use of pooled public funds (whether federal or more local) to support basic research in universities should be to ensure a steady stream of such people. Our system has done this well and provides good science, too, and it is in the country's best interest that the successful system be properly maintained.

There is currently furor about the inadequacies of our precollege school system, and that furor is based in large part on a perception of a lack of technical capability in the nation. This capability, which involves doing science, understanding science, translating science, and using the translation, must be fostered by an educational system both before and after 12th grade that is able to produce a suitable number of educated scientists and engineers. Past the college level the influx of federal, state, and private funds has done well so far in providing not only a steady stream of educated scientists and engineers but good science as well.

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The point at issue here is understood in a recent National Research Council report entitled "Renewing U.S. Mathematics. "On the first page the loos of support for mathematics is noted, "There has been declining attention to support of the seminal research," as well the fact that "opportunities for achievement in mathematical research are at an all-time high." The report does go on to note the paucity of mathematicians, but by the thesis advanced here the order as well as the emphasis would be reversed.

Although we are properly impressed by fine ideas and impressive new salients into our ignorance, we are often bemused by a less rational view of such things as ranking - "number one" and other such competitive trappings that develop in a vain desire to simplify evaluation of a complex system. This leads to an exhausting attempt by each field, each institution, each individual, to be number one. I have no interest in stifling ambition but intend rather to suggest that the process of educating individuals, because of the relative anonymity associated with it, has not maintained its proper preeminent position. This has also led to the ambivalent way in which the community has tried to support its legitimate call on tax funds.

(Science, 225, 4662 (10 August, 1984) p.577)

Know About Cryogenics

By Ganapathi Rao

(Extracts)

In simple terms, cryogenics is the science and technology of producing and maintaining low temperatures. The term cryogenics is derived from the Greek words: 'Kryos' meaning 'ice cold' and 'Genes' meaning 'born'. Similarly, cryogen refers to the substance used for producing low temperatures.

When we say low temperatures, an obvious question arises: how low is low? To answer this, we must first look at how temperatures are expressed. We are all familiar with the unit called Celsius (^{o}C); for example, water boils at 100^{o}C and freezes to ice at 0^{o}C. On this Celsius scale, negative temperatures also quite common. For example, the boilding point of liquid oxygen is - 183^{o}C. There is a more physically meaningful temperature scale known as the 'absolute scale' on which temperatures are denoted by the letter 'K' (in honour of Lord Kelvin). No physically obtainable temperature can assume negative values on this scale. Thus the theoretical lowest temperature limit is zero K. (This corresponds approximately to - 273^{o}C). If you want to convert degree Celsius to degree Kelvin just add 237K. Roughly, any temperature less than about 100K (i.e. - 173^{o}C) can be considered low enough to earn the title 'cryogenic temperature'.

One way to create low temperatures is to liquefy gases having low boiling points. Examples of cryogenic liquids (with boiling points in K) are: oxygen (90K), argon (87K), air (83K), nitrogen (77K), hydrogen (20K) and helium (4.2K). As is readily seen, some of these gases are present in the air: nitrogen, oxygen and argon. The fact that their boiling points differ is made use of in separating them from air, through a process known as rectification. (It may be of interest to note that the Air Separation Plant in our Centre routinely produce liquid nitrogen and can also produce liquid oxygen). On the other hand, hydrogen gas is produced by electrolysis of water (which consists of hydrogen and oxygen) or by chemical docomposition of methane (which is the major constituent of natural gas). Helium, which is present in minute quantities in some of the natural gas sources, is separated at low temperatures and high pressures. Helium gas can also be obtained by heating monazite sand which, incidentally, is available aplenty along the coastal regions of Kerala.

The basic process of producing low temperatures involves compression and subsequent expansion of cryogenic gases, just like in the home-refrigerator which uses the freon gas. Coming to cryogenic systems the main difference is that they use very efficient heat exchangers, expansion engines, expansion valves or even turbines. Since liquid cryogens boil off at very low temperatures, they need to be stored in

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special containers known as Dewars (named after the inventor Sir James Dewar); these are essentially double-walled containers with vacuum and/or thermal insulation material in-between the walls. The Dewars operate by reducing evaporation of cryogens by minimizing heat losses due to conduction, convection and radiation. Thus, is should be clear by now that success in designing and fabricating cryogenic systems is contingent upon a thorough understanding and intelligent application of principles of thermodynamics.

The applications of cryogenics are wide and varied. The traditional, large scale applications of cryogenics are in steel, copper and fertilizer industry. Some of the biological applications are in

- preservation of cattle semen for artificial insemination of cows and buffaloes for producing better yielding offspring.

- blood, bone-marrow and tissue culture preservation for use in emergencies

- cryo-surgery for removal of tonsils, treatment of Parkinson's disease (a disease of the central nervous system which causes tremors of the extremities), removal of brain tumors, warts, etc.

- whole body image scanners to detect the malfunction of any organ

- food processing known as individual quick freezing (IQF) of fish, prawn and meat for preserving their original flavour through long periods of storage and transport.

Local freezing of water or oil in pipelines by cooling with liquid nitrogen to create a temporary obstruction to the flow to carry out local repairs in the lines or to replace or instal components like meters and valves in them is another economical application of cryogenics. This procedure is very neat since it eliminates the need to discontinue the flow of liquid in the pipeline or to depressurize or drain the entire distribution system during repairs. Another application is in fitting a slightly oversized inner part into a mating hole by chilling that part to cryogenic temperatures which decreases its diameter. This is known as shrink fitting. Treatment of materials at low temperatures for obtaining better finished components and recycling of waste materials are becoming industrially important applications. Cryopumping, that is, creation of vacuum by condensing gas molecules on cold surfaces, is playing a vital role in the development of new and exotic electronic components.

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Another very exciting field of cryogenic application concerns what is known as superconductivity. The disappearance of electrical resistance in certain metals and alloys at very low temperatures is superconductivity. Thus, large currents can flow through superconducting wires without any loss of power or heating. This phenomenon leads to several applications. Powerful magnets built with superconducting materials are used in elementary particle research which aims at unravelling the mysteries of the microcosm. Superconducting transformers, motors and generators are much more efficient than the conventional systems based on ordinary copper wires. Superfast and portable table-top cryogenic computers that are comparable in performance with the present day computers will most likely be available within a decade. Japanese railway authorities are building a 'superconducting train' which travels in air (a few inches above a special track) at a speed of about 500 km per hour.

(Count Down, No. 52 (August 1984) pp.2-4)

Searches for Proton Decay and Superheavy Magnetic Monopoles

by B.V. Sreekantan

(Summary)

The existence of super-heavy monopoles and the phenomenon of nucleon decay, both of which are extremely important from the point of view of grand unification theories, are still very open question. While there has been just one magnetic monopole candidate so far, there have been several as far as nucleon decay is concerned. The first candidates for nucleon decay came from the fine-grain calorimeters of KGF, and NUSEX; recently there have been candidates from the water Cerenkov experiments as well. The experimental situation regarding the other important phenomena of relevance to grand unification which we have not discussed in this article - like the finite mass of neutrinos, neutrino oscillations, and neutron oscillations - continues to be indefinite though many dedicated experiments are in progress.

With the continued operation of the nucleon decay experiments already collecting data and the commissioning of the new generation of experiments over the next few years, the stage is set for a resolution of this problem in a time scale of 5-10 years. The present indication that the dominant decay mode for the proton (even if it decays) is not $p \rightarrow e^+ \pi^0$ and that the lower limit to the lifetime of the nucleon is 10^{31} yr, does not favour the simple SU (5) type models.

The remarkable discoveries of $W^{\pm}$ and Z^0 with mass values exactly as predicted, have given a boost to the unification based on the gauge theoretical approaches. Whether grand unification can be extended to super-unification, experiment along can tell. This will be the challenge for the remaining years of this century.

(J. Astrophys. Astr. 5, 3(1984) pp. 251-271)

Helioseismology

By Douglas Gough

(Abstract)

Sound waves generated in the solar convection zone propagate through the Sun and cause it to vibrate. Resonant vibrations are detected by measuring wavelike motion that they produce on the solar surface; by analysing them we can learn about conditions in the solar interior. At present we have only limited data but already we have drawn an important conclusion. We have inferred that outside the core of the Sun, and beneath the subsurface convection zone, the abundance of helium is about 25% by mass. It is generally believed that the intermediate region in the Sun is uncontaminated by the products of the nuclear reactions in the core and by material that might have fallen into the Sun from interstellar space. If that is indeed the case, we have measured the helium abundance of the gas cloud from which the Sun condensed some 4.7 thousand million years ago. This information is relevant to our understanding of the early stages of the evolution of the Universe. It is exciting that there are hints in the vibration data that might even enable us to determine whether the Sun really has remained unmixed, and hence whether we have a faithful record of the primordial mixture. There is also evidence in the data concerning the Sun's internal rotation. It appears that the core of the Sun rotates faster than the surface, but by how much is a subject of some controversy. It is very important to settle the matter, because the result is an essential step in one of the most important tests of Einstein's General Theory of Relativity. What evidence we have at present does not contradict Einstein's theory.

(Interdisciplinary Science Reviews 9, 3(1984) pp.240-249)

Continental distribution as a forcing factor for global-scale temperature

By E.J. Barron et al.

(Abstract)

Since the advent of the continental drift hypothesis, changing continental geometries have been proposed as an explanation for long-term temperature variability. The climatic influence of a few specific past geographies has been investigated quantitatively, but these studies do not indicate the potential temperature variability due to continental positions. This problem has been examined only with simple climate models having limiting assumptions such as no cloud cover. Here idealized continental geometries are used as boundary conditions in a simulation using a general circulation model (GCM) of the atmosphere. The range in model simulated globally-averaged surface temperature is 7.4 K with a difference in polar surface temperature of up to 34 K. The simulations suggest a substantial climatic sensitivity to continental positions with the coldest global climate when land masses are in high latitudes. Although the simulations have not captured theoretical limits of climatic variability due to continental positions, present-day geography is near the cold end of this spectrum.

(Nature, 310, 5978 (16 August, 1984) p.574)

Jets in Extragalactic Radio Sources
By David S. De Young

(Summary)

Observations now require that there be a continuous supply of energy to the giant extragalactic radio sources. These observations also suggest that this energy input may be in the form of streams or jets of gas emanating from the centers of galaxies and quasi-stellar objects. Current data indicate that the large-scale jet structures are not moving with relativistic speeds, as previously proposed. Slowmoving jets, which possess turbulent interiors and are dominated by relatively cool gas, can account for the observed jet properties at optical and radio wavelengths. Extremely small-scale jets observed adjacent to the central energy source may or may not be in relativistic motion.

(Science, 225, 4663 (17 August, 1984) pp.677-82)

Relativistic deflection of radio signals in the solar gravitational field measured with VLBI

By D.S. Robertson and W.E. Carter

(Abstract)

For an observer on Earth the general theory of relativity (GR) predicts an apparent outward displacement of a star seen at the Sun's limb of 1.75 arc s. A generalized formulation for gravitational deflection of light includes a parameter γ which ranges from 1 (GR) to -1 (no deflection). Early total eclipse measurements constrained γ by 20-40%, permitting alternative gravitational theories

Radio interferometer measurements of deflections of extragalactic objects and timing measurements of spacecraft signals have all been consistent with GR with increasing accuracy. We now report the most sensitive measurement of deflection so far achieved, in which very long baseline interferometry (VLBI) observations yield a value of γ of 1.008 with a 1σ formal standard error of $\pm$0.005.

(Nature, 310, 5978 (16 August, 1984) p.572)

Macro-Engineering
Advice to Heads of Government:
The Institutional and Intellectual Gap

BY Frank P. Davidson

Economic theories and economists are today close to the centre stage of contemporary politics. But when policy questions arise, clearly beyond the ken of economists and their companions in the social sciences, it has become fashionable to have recourse to science advisers. On the whole, this has been a step forward; in the United States, for instance, it has clearly been a good move to have the National Academy of Sciences define what is, and what is not, known about the causes of acid rain. But precisely because of scientific advances, government policy must now grapple with a congeries of issues which concern competing large-scale engineering ventures. It is the view of this editorial that most governments have not yet discovered reliable channels for the acquisition of the best available interdisciplinary advice on either the feasibility or the desirability of major technological projects: we are in a semantic and institutional morass.

Because of a disorientation only beginning to catch the attention of commentators and practitioners, neither the United Kingdom nor the United States has been able to put its best foot forward in adapting to the heightened pace of international technological competition. For similar reasons, neither country has been able to offer a coherent program for international technical cooperation. Perhaps a few blunt remarks are in order. First of all, the underlying raw material of what we call economics consists largely of the activities subsumed under the rubric of engineering. That is, before economic transactions can occur, products and services must be conceptualized, designed, produced, tested, transported and assessed - in short, engineered. A too-exclusive preoccupation with business cycles (long-wave or short-wave), money supply, and other perfectly legitimate and respectable questions has in fact diverted attention from the invariable constraints with which practical programs must deal. A continental water shortage, like the energy crisis which the world seems so determined to forget, cannot be dealt with on a short-term, stop-and-go basis according to the prescriptions of prevailing economic theories. The ancient Romans were nearer to the mark when they reacted to water shortages on the edge of the Sahara by building a large-scale network of aqueducts, pipelines, tree-breaks and supply roads. No modern government has been able to match their achievements in developing and preserving a flourishing civilization in the teeth of the Sahara. Our contemporary age has preferred macro-conferences to macro-engineering.

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Engineering and Diplomacy

Modern diplomacy has been impoverished by its inability to integrate technology policy and foreign policy. It is no accident that the Suez Canal was finally accomplished by a retired diplomat, Ferdinand de Lesseps; we have, near Boston, the excellent Fletcher School and by Tufts University. But where are the Schools or Centers for Engineering and Diplomacy? Even most French people have forgotten that when the famous Ecole Polytechnique was founded - in 1794 - its original title was the Ecole Centrale des Travaux Publics.

When Lyndon Johnson was President (1963-1969), he turned for advice on Central American turmoil to his principal political backer, the late George R. Brown. Mr. Brown has been much criticized of late, but I remain convinced that President Johnson was fundamentally right in turning to an experienced engineer- manager for guidance on how to dramatize the future of a whole region. He decided to conduct a major series of studies concerning the location of a second trans-isthmian canal, and this provided a focus of interest for all the countries of that area. Today, with Japan's veteran Shiego Nogano urging international sponsorship of new canal, there is clearly a political opportunity of great potential importance. That President Reagan has as his Secretary of State a man who has presided over one of the leading engineer-managed firms in the world, is not a mere accident: engineering should be front and center. The usual science adviser has not had hands-on experience with major engineering systems. The study of the design, impacts, organization, management and assessment of large-scale technological projects has given rise to a new interdisciplinary field of study, often described as macro-engineering. But there are very few institutions in any country that combine advanced training in engineer-management with a career path that leads to senior policy and management positions - this is, or should be, on the priority agenda of both developed and developing nations, if they are to take full advantage of the positive potentialities of high technology, particularly when this is added to humankind's age-old proclivity for organizing masses of people to accomplish designated physical tasks such as, for instance, building the Pyramids or - in our own time - the Chinese-built railroads in Africa.

Engineering Our Future

If engineering - to paraphrase Voltaire - has become "too important to be left to engineers," it is, nonetheless, insufficient to have decisions on engineering policy to traditional liberal arts or even social science denizens alone. "Experts on tap, not on top" is no longer an aphorism we can safely admire. The famous Finniston report, Engineering Our Future, could well be followed up by a broad series of of initiatives - and not only in the United Kingdom - to re-orient a liberal arts education so that technological competence does not become a barrier to advancement to gentlemanly posts. Schools of management must now - perforce - include as a central part of their curriculum the principal engineering activities which are to be managed; and with alternating waves of nationalization and privatization, it no longer makes much sense to have separate schools which train competing elites in business management and public administration.

Politicians Uninformed

Engineering systems are becoming continental and planetary in scope. Telecommunications are now plainly worldwide; transportation networks were global even in the days of sailing ships, but the next century will see the advent of alternative systems which can provide a two-hour service between any two points on earth. While North America urged Europe to institutionalize a federated economy after World War II, North America itself remained virtually devoid of continent-wide bodies for consultation and cooperation. The world's institutions are, to a large extent, anachronistic in an epoch when technological advances, wisely selected, can work efficaciously for environmental and social improvement. If politicians' perceptions of what is now possible are so uninformed, where can a conscientious head of government turn for advice?

Engineers to Broaden Their Culture

One cannot give a pat answer; much depends on the pace and range of the emerging awareness that all elements of society have a stake in - and must become knowledgeable about - modern technology. And engineers themselves must broaden their culture so that constitutional history, finance, art and sociology are no longer regarded as extraneous to the new profession of engineer-management. That this means a lessening of incrementalism and the acceptance of a more sweeping logic that can transform institutional structures should not be regarded as a threat to cherished habits and foibles. Unless we clear our mental decks for action, other more coherent centers of power and influence will prevail. Until we have schools that turn out experienced engineer-managers with broad culture and humanity, heads of government will be well advised to seek engineering advice from individuals who have earned their spurs in the workaday world of specific achievement. As a living model of the mature, broadgauged individual who must now come forward, I would like to cite the brilliant British-born architect, Peter Land, who built a demonstration town, El Proyecto Experimental del Vivienda, on the outskirt of Lima, and proved that a large-scale conception can be carried out with the sensitivity and taste required for civilized living.

Practical Prescience Needed

Macro-projects can of course involve bloopers as well as bonanzas, but a Luddite negativism is a prescription for steady decline, not an ethos that can inspire a whole society with the desire for excellence. There is no way out: we must apply ourselves to the systematic listing and appraisal of new engineering systems - on land, at sea and in the realm of aerospace - so that our politics may come alive once more. Scientific advice will remain essential. But it is insufficient as a supplement to economic advice, especially when technological options involving practical judgement of social, environmental, financial and political issues call on that rare quality, practical prescience.

International Engineering

Kathleen J. Murphy, in her landmark study, Macroproject Development in the Third World, published the awesome statistics: in the past decade alone, more than $10 was invested in technological projects amounting to at least $100 million each in the developing countries alone. The question of large scale is no longer exceptional: it is, increasingly, a principal instrument of corporate and governmental action. When mining asteroids or building undersea tunnels of great length can enter the agenda of serious contemplation, heads of government - and indeed those responsible for decision-making in a multitude of institutions - need to look more closely at the structure of their advice. Computerized decision support systems can surely play a useful role, but it is the spoken - and written - word of trusted counselors which will carry the day. Curiously, in large engineering matters, it will be the financiers - not the engineers - who are likely to have the better grasp of what can be financed. Lawyers - like Lloyd Cutler, who really put together the Alaska Pipeline, or George W. Ball, who, when the story is finally told, will be given much of the credit for Jean Monnet's staff work which preceded the establishment of confederal institutions in Western Europe after World War II - have a vital role to play. Ernst G. Frankel, the naval architect and marine engineer, who now circles the globe in an advisory role for the World Bank (the International Bank for Reconstruction and Development), can give cogent opinions on the future alignment of ports and artificial islands. We are entering the new paradigm of intercontinental engineering, and people who think in terms of yesterday's technologies simply cannot give reliable guidance on high policy to those whose judgements will end up not only in the black and white of laws and directives but in the steel and concrete of the built environment which will establish the context for tomorrow. As George von Langerke Meyer - the friend of Theodore Roosevelt who was sent out as Ambassador to St Petersburg in the false sunshine before World War I- wisely remarked, "Things alter for the worse spontaneously, unless altered for the better designedly."

(Interdisciplinary Science Reviews, 9, 2,(1984) pp.103-105)

Olivetti uses compression code to cut voice I/O memory need

By Robert Gallagher

Research engineers at Ing. C. Olivetti & C. are getting closer to one of their highest-priority goals - that of enabling office workers to use spoken language for inputs to and outputs from sophisticated data-processing and office automation systems. The company already has several working prototypes of voice I/O tools that could significantly cut the drudgery of many mundane office tasks and increase efficiency in other office routines.

The company's thrust is concentrated in the fields of voice coding, speech synthesis from text, and speech recognition. Olivetti has applications clearly mapped out in the first two cases, but its phonemebased recognition program is by far the most ambitious of the three (Electronics, May 19, 1983, p.88) and longer development is expected.

Nonetheless, Olivetti feels it has recently made some important strides, and its machine is now able to distinguish, with high reliability, between words such as "make," "lake," and "take" after a five-minute session with the operator, who trains the machine by reading a set text. One key to the Olivetti recognition system is the company's proprietary method for establishing an "energy profile" of the operator's speech.

Olivetti's work in voice coding is more focused. The company sees the technique as the medium through which an electronic voice-message service that could be integrated into an office automation environment will be realized. There is no great difficulty in recording a voice using electronic media, particularly when a digital network serves as input. What does present a problem is storing it without using a prohibitive amount of memory. A pulse-code-modulated signal at 64 kb/s, for example, requires 8-K bytes of memory to record 1 s of speech.

Olivetti has reduced this requirement by about 60% to 3-K bytes for a second of speech using a technique called adaptive delta PCM, which codes differences in the speech signal, rather than the entire signal. By suppressing or by coding the silence intervals the company has achieved a further reduction to 2.25-K bytes.

The company's prototype system lets the user choose whether to store messages at 4-, 3-, or 2.25-K bytes for a second of speech, the choice determining the quality of the recorded messages. Vittore Vittorelli, manager of the voice processing laboratory, points out that the quality of even the 2.25-K-byte coding is perfectly acceptable, with the difference being an esthetic one.

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The system works by amplifying an incoming voice message, sending it through a low-pass filter, and then coverting it into digital form for storage. To play back a message, it reverses this process. Olivetti's prototype can store only 7 s of speech in a random-access memory, but in practice such a memory will serve only as a buffer for storage on disk.

While voice coding is transparent in terms of language, speech synthesis and recognition confront a great many problems due to linguistic factors that are usually far from the world of electronics. In the case of synthesizing speech from text, those problems start with creating understandable, and then attractive, natural-sounding speech.

An ideal application for synthetic speech from text would be in proof-reading. The company has so far developed a prototype system that will record numbers from an electronic typewriter, and then read them back to the typist for checking.

This requires a far more sophisticated system than one might expect. If the typist types the number "221," for example, the system must translate that into the corresponding verbal expression "two hundred and twenty-one." In the case of actual text, the difficulty increases exponentially. "April 2nd" would thus become "April the second," and "Dr." would be expanded to "Doctor."

After this stage comes a conversion from text to phonetic symbols - relatively easy in Italian, devilishly difficult in English - after which syllable stress is assigned. In French, a further operation is required to determine "liaison," or connecting sounds between words.

After ambiguities are sorted out (like the difference between the homonyms "lead" and "lead"), the duration of each element of the phonetic string is determined and the appropriate pauses are inserted to divide the sentence into breathing groups. Finally, a semantic analysis corrects any improper assignment of pauses that could hinder or change comprehension, as in the two statements, "the sentence (pause) analysis is critical" and "the sentence analysis (pause) is critical."

(Electronics Week (August 13, 1984) pp.13-14)

Wafer-stepping gains impact TI's Impact

Advances in production equipment can open the door to changes in semiconductor technology, but the evolution of manufacturing systems can also delay or even eliminate the need for new processing techniques. Take Texas Instruments Inc.'s most advanced oxide-isolation bipolar process, called Impact: implanted advanced composed technology.

When first developed in the early 1980s, Impact combined conventional projection printing with emerging wafer-stepping lithography. The process represented a revolutionary departure from TI's existing advanced low-power Schottky technology. It was designed to drive bipolar features below 2 μm, while minimizing the number of critically aligned mask steps, which had to be handled by very accurate but slow wafer steppers. Oxides were grown instead of removed.

Enhancements in wafer-stepping equipment that boosted throughput 24 times and a general movement to 6-in. silicon slices have eliminated the benefits of the changes. Instead, wafer-stepping lithography and new design rules will be used in all levels of the existing ALS process, now at the 3-μm level for TI'sALS and advanced Schottky logic components.

The result is a new but more conventional 2-μm Impact that almost achieves the bipolar performance of the revolutionary process. For starters, the new Impact is being used on TI's new high-speed programmable logic devices and programmable read-only memories. However, the original Impact, which still has 4-μm metal pitch features (the new Impact has 7-μm) is still being used to prototype TI's AS888 and 889 8-bit bit-slice devices. TI is now considering converting the bit-slice processors to the new Impact for processing standardization. The new Impact represents little change to the processing front end from AIS and IS. The difference is that wafer stepping has totally replaced projection printing, and transistors are 1.05 mil instead of 1.94 mil.

(Electronics Week, 57, 15 (July 23, 1984) p.21)

The radioactive waste management conference

By S. Fareeduddin and J. Hirling

(Summary)

Nuclear Energy has been used on an industrial scale to generate electricity for nearly 30 years. The industry may thus be said to have reached maturity. Problems in the management of radioactive waste have been resolved adequately in the past; but given increasing concern about long-term safety and environmental protection they are becoming ever more crucial in the struggle to achieve eventual acceptance of nuclear power as a global, industrial source of energy.

It was therefore felt timely to organize earlier this year (1983) an international conference to review the entire spectrum of issues in radioactive waste management, and their bearing on national nuclear power programmes. The conference was held in Seattle, Washington, from 16 to 20 May. The response was gratifying, reflecting world-wide interest; it was attended by 528 participants from 29 Member States of the IAEA and eight international organizations. There were 21 sessions, at which 149 papers including a report on the IAEA's own work in this field were presented. An additional session was given over to two panel discussions, one on prospects for further international collaboration and the other summarizing the results of all the technical sessions.

The conference programme was structured to permit reviews and the presentation of up-to-date information on five major topics:

- Waste management policy and its implementation: national and international approaches; legal, economic, environmental, and social aspects;

- handling, treatment, and conditioning of wastes from nuclear power plants and reprocessing plants, including the handling and treatment of gaseous wastes and wastes of specific types;

- storage and underground disposal of radioactive wastes : general, national concepts, underground laboratories, and designs of repositories for high-level, and low- and intermediate-level waste disposal;

- environmental and safety assessment of waste management systems: goals, methodologies, assessments for geological repositories, low- and intermediate-level wastes, and mill tailings; and

- radioactive releases to the environment from nuclear operations: status and perspectives, environmental transport processes, and control of radioactive waste disposal into the environment.

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The opening session of the conference was addressed by the IAEA Director General, Dr. Hans Blix, and by representatives of the US Government and of the State of Washington. Mr. M.J. Lawrence, Deputy Director of the Nuclear Waste Policy Act Project Office of the US Department of Energy, said this conference was "especially appropriate and timely" as it focussed on "a challenge that the international community must meet successfully if we are to assure the nuclear power for all", and on "an area where close international co-operation is demanded by our common interest in an acceptable global environment".

The tone of the conference was set by two keynote addresses, on the status of technology in waste management, and on major trends in research and development work in the implementation of waste management programmes. The first speaker was Mr. J.A. Liebermann, a pioneer in US waste management since the 1950s, who concluded that the technology is available to enable us to locate, design, construct, and operate waste management systems that meet stringent radiation protection requirements at acceptable costs, and that no technological breakthroughs are required. The second speaker was Mr. J.F. Lefevre, Director of the Department of Wastes and Effluents in the Commissariat a l'Energie Atomique, France. Both speakers recalled the long experience and research in raioactive waste management that now forms a solid base for implementing industrial systems and specific projects.

The Agency presented a report on the objectives, activities and results of its own waste management programme, with emphasis on recent developments and collaboration with other international organizations in relevant areas. Attention was drawn to the systematic and comprehensive work that has already been done or is under way internationally to assist in the implementation of national waste management programmes and to resolve related international issues.

Waste management policy and its implementation

The 27 papers from 16 countries and four international organizations in this subject area showed that governments are aware of the need for proper and timely implementation of radioactive waste management systems, including the definition of the related regulatory, institutional and financial arrangements. Policy decisions have already been taken in many countries. The spectrum ranges from those which plan to expand their nuclear programmes in coming years (such as Egypt) to those whose current nuclear policy forsees the use of nuclear power only until about 30 years from now (Sweden). Many countries have programmes with mandated schedules for the implementation of geological repositories for high-level wastes or spent fuels (USA), or for the selection of appropriate sites (for example, Argentina, the Federal Republic of Germany, Sweden, Switzerland), but there are some shose policy-in effect-calls as part of an overall waste management strategy for the deferral of decisions to proceed with the construction of such repositories (UK).

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Some well-defined common ground was evident. The basic driving force for policy decision was seen to be the need to assure the protection of human health. A well-defined legal, regulatory, institutional, financial, and administrative framework for the implementation of policy exists or is under active discussion in many countries. There was a general acknowledgement, even a consensus, that adequate technology for the safe management of radioactive wastes is available.

In many countries, underground facilities for the disposal of low- and intermediate-level wastes have already been established (for example, in France, India, the German Democratic Republic, the USSR, UK, and (USA). In these and other countries national disposal concepts designed to meet the long-term requirements of nuclear programmes are being developed. There is a general tendency to employ land-based alternatives to the sea-dumping of nuclear wastes, though sea disposal is of continuing interest in some countries (the UK, Japan, Belgium, Netherlands, and Switzerland).

Socio-political issues related to waste management, generally recognized as posing problems for the further growth of nuclear power, were a reasonably common though perhaps not universal feature for discussion and resolution. While there is a need to put the risks of radioactive waste management in a proper perspective, to gain public understanding and acceptance, achieving this objective is a difficult task which needs national and international attention.

Available information on the economic implications of waste management indicates that including the full costs of spent fuel storage and final waste disposal will increase their proportionate share in the total cost of nuclear power (figures exceeding 10% have been mentioned). The costs of waste management are charged mostly to the price of electricity, and regulations to permit this have or will become effective in Sweden (2.3 mills per kWh), USA (1 mill per kWh), the Federal Republic of Germany (6 mills per kWh), Switzerland (5%), and so on. Though such costs are higher than had been assumed previously, they do not seem likely to have a serious or decisive impact on the use of nuclear power and this even in countries with small nuclear programmes. Economics was not and will not be a major driving force for simplifying or reducing conservatism in radioactive waste management systems; elaborate systems that meet long-term safety and stringent radiation protection requirements can be afforded, even though they may not always be justifiable on technical grounds.

Some countries have set up special institutions to implement or operate waste disposal or spent fuel management systems which cannot be handled properly by the utilities themselves; for example, ONDRAF in Belgium, ANDRA in France, the SKBF in Sweden, NAGRA in Switzerland, and NIREX in the UK. In the USA, the Department of Energy has, in implementing the Nuclear waste Policy Act signed by President Reagan in January 1983, established a new office exercising responsibility for civilian radioactive waste management, for the development of interim storage facilities and repositories for the storage and disposal of high-level radioactive waste and spent nuclear fuel, and for establishing a programme for research, development, and demonstration for these and other purposes.

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The positive role of international organizations was generally recognized, while noting the understandable fact that the larger the membership of an organization the more general its approach tends to be. The value of the IAEA as a source of information and guidance was evident. International co-operative ventures in waste disposal and in particular the wish of smaller countries to have acess to repositories in larger nuclear countries or to be able to transfer spent fuel, were discussed on more than one occasion, but operational activities in this area were acknowledged to be premature.

Waste handling, treatment, and conditioning

The 35 papers in this series of sessions reviewed techniques and experience in the handling, treatment, and conditioning of low-, intermediate- and high-level wastes that arise in the course of operation of nuclear power plants and reprocessing plants, from decommissioning operations and from some other nuclear facilities including those associated with advanced fuel cycles.

The surveys were based mostly on recent reviews by international groups of experts. They showed that techniques for handling low- and intermediate-level wastes have been proven by industrial experience though this does not diminish the need to search for further technological development. An remarkable effort has been undertaken in countries of the European Communities to characterize the properties of low- and intermediate-level waste, in order to obtain the required level of quality assurance for waste forms and packages for storage and disposal, and establish a data bank. Similarly, the results of the IAEA co-ordinated research programme on the evaluation of conditioned high-level waste forms showed the importance of common investigation methods, and assessing the behaviour of the waste forms under "real" repository conditions.

A number of pilot or prototype plants for the vitrification of high-level waste are under construction or are undergoing active testing in a number of countries. Industrial experience with "real" high-level waste vitrification has so far been gained only in France. A peper on the treatment of special wastes at Three Mile Island Unit 2 drew attention to the variety of problems that might arise when decontamination measures and remedial actions have to be undertaken after accidents affecting nuclear facilities. An international review on the decommissioning of nuclear facilities showed that the body of experience and capability in engineering and planning is adequate to allow the making of reliable cost estimates, and the implementation of appropriate measures for ultimate disposal of decommissing wastes.

A presentation on the management of waste arising at nuclear power plants dealt with techniques of compaction, incineration, bituminization, and cementation, and with specific problems associated with the handling of spent ion-exchange resins and tritium-bearing wastes. The importance of further improvement in volume reduction techniques was underlined, in particular to ease interim storage: the Federal Republic of Germany, for example, aims to reduce the volumes of waste from nuclear power stations by a factor of five.

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The most important problem in the management of gasesous wastes is the recovery and storage of significant quantities of four radionuclides- krypton-85, iodine-129, tritium, and carbon- 14- originating from the dissolution of fuel in reprocessing plants. Release of any of those radionuclides would result in increases in the does commitments of people in both regions around the plants and world-wide. The management of airborne contaminants is complex because their recovery, immobilization, and storage require different technologies for each element. Recovery and storage of iodine-129 and to a lesser extent carbon-14 and krypton-85 appear to be justified. None of the criteria evaluated support a decision to control release of tritium, therefore its recovery was not recommended.

A CEC paper contained an overview of R&D activity in the management of radioactive waste from the decommissioning of nuclear power plants. Highly efficient decontamination techniques are being developed - in particular, using a chemically aggressive decontaminant in liquid and gel form. Electrochemical and hydromechanical techniques are also under examination. Some encouraging results have also been obtained in the decontamination of concrete surfaces by rapid heating, causing a thin layer to fall off.

National experience and approaches for managing all kinds of radioactive wastes from reprocessing plants were presented by authors from France, the Federal Republic of Germany, India, Japan, the UK, and USA. These countries have built effective treatment plants which are either in industrial use, or are at the demonstration stage; and many years' experience from industrial operations has been acquired. The use of techniques such as evaporation, co-precitation, incineration, and compaction, measures to recover plutonium, bituminization, and cementation for the conditioning of low- and intermediate-level wastes are common. Comperhensive reviews were given on US experience and projects for treating and conditioning the great variety of wastes produced by the reprocesing plants at Hanford, Idaho and Savannah River. Experience gained at the French reprocessing plant at La Hague, including provisions for new facilities being built at that site, was also presented.

Considerable efforts are made to treat and condition wastes stored for final disposal at US Department of Energy plants, in accordance with the requirements of the US Nuclear Waste Policy Act of 1983. Techniques for the separation of caseium-137, strontium-90, krypton-85, and americium-241 from high-level waste have been developed and applied.

Experience reported from UK reprocessing plants drew attention to the fact that questions of managing intermediate-level wastes have become more important than those of managing high-level wastes, for which vitrification plants are being built.

Particular efforts are being made at the Wiederaufarbeitungsanlage Karlsruhe (WAK), in the Federal Republic of Germany, to improve plutonium recovery and the treatment of organic solvents and to reduce the volumes of waste arisings. A programme in India, where a vitrification plant has been constructed, and pilot plants in Italy are based on technologies that are similar to those used in other countries.

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Other papers reported the status of vitrification pilot plants in Belgium, the Federal Republic of Germany, Italy, the USSR, and at the US West Valley site where waste from previous commercial reprocessing activities is being stored. Other examples of improved technologies for treating low- and intermediate-level wastes are the acid digestion process for the treatment of combustible alpha-waste - a preliminary step in plutonium recovery - and the slag incineration process used in Belgium for the integrated treatment of alpha-, beta-, and gamma-emitting materials. This latter would appear to be a particularly promising process for achieving high volume reductions and stable waste forms. The Synroc process as an alternative to vitrifying high-level waste is being given further study in Australia; investigations there include assessment of the industrial feasibility of this process in pilot-scale plants, and research into alternative waste-rock compositions including those incorporating spent fuels in solution.

All the presentations indicated that the technology for managing high-level and alpha-bearing wastes at reprocessing facilities has passed the R&D stage, and in now sufficiently mature to be introduced on an industrial scale in plants in operation or under construction in various countries. There is, however, room for further improvement and there are also areas which might require further study. This is true particularly of the recovery of gaseous nuclides such a krypton-85, iodine-129, carbon-14, and tritium. Experience to date in France with wastes from fast breeder reactors and their fuel cycle indicates that these wastes are manageable and will not pose substantially new technological problems.

A general conclusion from all the presentations in this series of sessions is that the technical means for managing radioactive waste at nuclear facilities are proven and available. Their further development need not be an obstacle to current nuclear power programmes.

Storage and underground disposal of radioactive wastes

The 35 papers in this series of sessions dealt with experience, actual practice, and further improvements in the underground disposal of low- and intermediate-level wastes, and with the storage of spent fuels and high-level wastes. The well-advanced status of conceptual developments and practical preparation for the final disposal of high-level waste and spent fuel were described in extenso.

The common ground in all the work presented lay in the need for generally accepted radiological protection objectives for the underground disposal of radioactive waste which will enable the derivation of criteria for the different disposal options. The guidelines given in some recent IAEA reports - such as Safety Series Nos. 54, 56 and 60, prepared as a part of the Agency's programme of work in this field - would be of relevance in this context.

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For spent fuel and vitrified high-level waste two stages - interim storage and final disposal - must be distinguished. Two papers discussed the storage and handling technology available. Two decades of experience of spent fuel storage lead to the conclusion that it can be used for several more decades, leading time to determine without haste the optimum timing for the transition from storage to final disposal. With respect to final disposal of either spent fuel or vitrified high-level waste, a number of papers showed how repository concepts have been developed and site surveys carried out using geophysical, geochemical, and other methods of investigation. Results obtained for different rock types such as granite, salt, clay, basalt, and tuff show clearly that radiological protection objectives can be achieved in various ways. A Swedish paper describing the concept of disposing of packaged spent fuel in a granite repository was of particular interest. It concluded that the present technology is such that it is possible to acquire knowledge adequate to make predictions far into the future, and that the total respository system would provide protection well beyond the requirements of society today.

An entire session was devoted to underground rock laboratories and pilot projects in which very large resources have been invested in Belgium Canada, the Federal Republic of Germany, Sweden (the Stripa project). Switzerland, and the USA. The pilot projects are obviously very much system-dependent. They vary according to disposal concept and type of host rock: granite (Canada, Sweden, Switzerland, USA); salt (the Federal Republic of Germany, USA); clay (Belgium); basalt (USA); and so on. The presentations showed how the objective of establishing deep geological repositories can and will be reached. The conceptual methodology used is quite similar in Argentina, Belgium, Canada, France, Sweden, Switzerland, and the USA. In all cases but one, repositories are planned to accept high-level waste well after the turn of the country - the exception being a repository in the USA in basalt, tuff or salt which should be operational in 1998.

The situation is different for the disposal of low- and intermediate-level wastes, in shallow ground or in repositories in rock cavities. Disposal in shallow ground has been in practical use for decades and many papers presented an interesting compilation of the experience gained in France, India, and the USA. In earlier disposal operations, the packages were often not planned to provide a confinement barrier which would last a long time (for example, some containers were made of cardboard). Nevertheless, measurement in associated groundwaters of specific radionuclides over periods of many years permit the conclusion to be drawn that under normal hydrological, topographic and climatic conditions releases are well within acceptable limits.

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One paper dealt specifically with geohydrological problems in shallow ground disposal in the USA. In spite of identified problems which have resulted from earlier and current disposal practices, the authors were nevertheless optimistic. They stated that none of the problems observed has resulted in apparent human harm, that the experience gained in investigating problems of radionuclide migration has led to a better understanding of earth science requirements, and that each of the problems identified is amenable to practical solution by appropriate site selection, design and operation of the repositories.

A number of papers showed progress in repository design. Repositories range from unlined underground trenches to above-ground mounds and monoliths. The newer designs of the latter type in France has a built-in water collection system which allows control over radio-nuclide migration out of the repository.

The use of cavities in rocks of different types, whether they are abondoned mines or special excavations, seems to be gaining in importance in the disposal of low- and intermediate-level wastes. Some countries have operational experience of rock cavity repositories (the Federal Republic of Germany (abandoned mines), the German Democratic Republic, and Spain), and others are planning to construct such repositories in hard rock (Finland, Sweden, Switzerland, and the UK).

Management practices for uranium mill tailings were reviewed with an emphasis on recent attempts to reduce environmental impacts. Efforts are being made, supported by Governments, to improve the protection of groundwaters and to reduce the release of long-lived radionuclides of environmental significance. Countries concerned with such problems are aware of the long-term implications of releases from mill tailings and are looking accordingly for improved methods of containment and management.

Goals and methodologies for environmental and safety assessments

Twenty-six papers were presented in the sessions dealing with the environmental and safety assessment of waste disposal systems. There was considerable discussion of the basic criteria for setting the goals, and a consensus on requirements for present and future dose limitation. The philosophy of the International Commission on Radiological Protection seems to have become well-accepted. It was suggested that a fraction of the dose limit for individuals should be used as an upper bound. Difficulties were encountered in the discussion of doses which might result from disruption of a repository, as events of both high and low probability of occurrence are involved.

Factors that would have to be considered in the optimization of radiological protection were discussed at length. An interesting part of this discussion was the clarification of problems in the integration of collective doses in the extremely far future. It became clear that the only relevant part of the collective dose is that which is influenced by choice of option, because the remaining part cancels out in the substraction from one option to another. That would make attempts at

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assessment over shorter times more reasonable than integration over geological times. Another interesting point is that in selecting options one would have to consider that part of the collective dose which is less uncertain, because if the overall value is taken with its enormous uncertainties, determination and precision in the selection between one option and another are lost. Of these two factors, the part which influenced by choice of option and the part which is less certain would determine the period of integration into the future - which cannot be infinite.

There was discussion on ways of choosing between options. One was cost-benefit analysis, which seems quite transparent as long as the major decisions are made beforehand regarding some of the components. Other methods such as decision analysis were also discussed, and there was considerable discussion of what is "reasonable". Those who carry out assessments seem to have a preference for standards based only on individual future doses, with some sort of acceptable value of uncertainty and perhaps some criteria for the reduction of dose. But, on the whole, approaches seem to be converging towards the application of a sophisticated radiation protection philosophy to the assessment of waste management practice.

There were papers dealing specifically with safety assessments in the disposal of low- and intermediate-level wastes, and mill tailings. In the case of mill tailings attempts have been made to use or at last to outline what are basic issues in optimizing decisions. There has been some analysis as well of technologically feasible ways of reducing radon emisions, and of assessing their real significance in the long-term. With respect to low - and intermediate-level wastes, the key issue is probably the attempt to quantify what is meant by "safety" and not merely the assessment of whether a system is "good" or "not good". There have been some analyses of "normal" mechanisms of release by water transport, and comparisons with criteria based on individual dose. The most probable disruptive event has also been identified: for example, perforation of the formation; and assessments of the minimum surveillance time needed to ensure compilance with basic goals. Discussions on deep geological repositories related mainly to assessments of safety and performance. There were also papers on assesment of the safety of idealized repositories in differing rock types, and on site-specific assessments. In all cases, the performance of the different barrier systems was analysed, starting with the actual dissolution of the matrix containing the waste, moving to the package, buffer, and barrier materials and their behaviour, migration through the rock system to the biosphere, and ending with an estimate of the resulting population doses.

A study on environmental impacts - part of a more comprehensive study of geological waste disposal carried out by the Waste Isolation system Panel of the National Research Council of the USA - was reported by Thomas H. Pigford, Chairman of one of the panels, Site-specific hydrological and geochemical parameters supplemented with generic parameters, where necessary, enabled calculation of future radiation doses to maximally exposed individuals, for conceptual repositories in basalt,

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granite, salt, and tuff. These were compared with a performance criterion of 10^{-4} Sv.y^{-1} for radiation exposure from "probable" events. The maximum expected individual dose was shown, on the assumptions of this study, to be much below the performance criterion. The study also made a number of recommendations and conclusions. These included the need for a well-defined general criterion that defines a acceptable overall performance of the geologic waste isolation systems; guidelines and approaches to be taken in the technical and other areas; and means of reducing uncertainties in predictive accuracies for future releases to the environment.

Papers presented in these sessions showed how sophisticated safety assessments have become. Perhaps the most important point is that a considerable amount of data arises which is not very definite and that sensitivity analyses are therefore extremely important, especially in quantifying the effect of uncertainty in different physical parameters. Some physical parameters have a strong effect on the end result while others do not. Also, the way in which uncertainties are approached is quite different. In the "deterministic" approach the uncertainty would have to be taken into consideration in maximizing the final collective dose for comparison with some sort of goal. In the case of the "probabilitistic" approach best estimates in combination with the corresponding probabilities are necessary.

Environmental transport processes and models

The 23 papers in the sessions on environmental transport processes and model dealt with the development of technical means for assessing the consequences of releases to the environment. One paper, describing a model for the transport of long-lived radionuclides released to the environment, pointed out some deficiencies in models for the transport of tritium and iodine-129, particularly when doses close to the point of release are required. Another paper was a preliminary report on what will eventually be a most important international intercomparisions, the INTRACOIN project. This is comparing some 20 computer code for modelling radionuclide transport in the geologic far field; taking part in the study are modelling groups from Canada, Denmark, France, Sweden, Switzerland, the UK, and USA.

Several papers concerned with investigations and measurement emphasized the complexity of the environment and the sensitivity of radionuclide transport to chemical and biochemical interactions. In particular, the effect on nuclide mobility of association with complexing agents such as EDTA and other organic species such as carboxylic acids is being studied at the Maxey Flats low-level waste disposal site in the US.

There is clearly a need for more realism in predictive models as emphasis shifts to site-specific studies and concentrates more on optimization of waste disposal facilities and procedures. On the other hand it will be a daunting task if models are required to simulate in detail all the complex interactions in the conditions of an actual disposal site. It is necessary to find the right balance.

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Most papers in the session on the control of radioactive waste disposal to the marine environment were concerned with the sea-dumping of packaged solid wastes. Considerable internationally co-ordinated research is being carried out at present within the various disciplines needed to re-assess the hazard from sea-dumping and to look again at the definition of high-level waste formulated by the IAEA. Several papers described aspects of this research, including an oceanographic modelling review just completed by the UN joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP), the co-odinated research and environmental surveillance programme set up by the Nuclear Energy Agency of the OECD (NEA) and experimental measurements being carried out at the IAEA International Laboratory of Marine Radioactivity in Monaco. The consensus of these papers is that improved, more appropriate, and more realistic models will be available soon, for use with the improved data base now being generated, to carry out the various studies which are needed. None of the investigations, carried out to date indicate that previous assessments of the hazard have been too low. If anything, more processes retarding the transfer of radionuclides to man have been identified. This is a clear area where international scientific collaboration is of the essence, and the IAEA continues to play a crucial and active role.

Two papers dealt with the possibility of disposing of high-level waste on the seabed. Work on this topic is being carried out under the auspices of the NEA Seabed Working Group and the development, current organization, and programmes of this Group were described in one of the papers. It seems that seabed disposal is technically feasible, but there are many technical questions and institutional issues which require resolution before this option could be considered for implementation.

There was an informative review of the public exposure resulting from the discharge of transuranium nuclides to the sea from Sellafied, in the UK (perhaps better known as Windscale). The UK paper emphasized the role of feed-back from measurement programmes in assessing dose and the difficulty of predicting realistically doses in the future from such long-lived radionuclides.

The results of a nine-year field study of radionuclide migration from a low-yield underground nuclear test explosion in tuffaceous alluvium at the Nevada Test Site were presented in a US paper, which indicated that most of the radioactivity was found to have been retained in fused debris in the cavity region. Samples obtained at depths from just below the ground surface to 50 metres below the detonation point were analysed: it was found that no activity above background levels was present in the deepest samples, and that only tritium and strontium-90 were present in water in the cavity at levels greater than the concentrations recommended for water in uncontrolled areas.

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Several other papers in this session, which was concerned with releases to the environment from nuclear generation, reviewed general levels of environmental contamination and consequent doses. An example was a summary of the 1982 report of the UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). There were also discussions on procedures for authorization of discharges, and on the need to consider broader possibilities in optimization such as comparing hold-up, solidification, and disposal with direct discharge for some nuclides. A further problem lies in determining what allowance should be made for build-up in the environment and for doses delivered far into the future at points distant from the discharge site.

An important international development is the effort to try to reach agreement on the control of transffontier pollution. The key to this is recognition that at much weight should be given to doses delivered to "foreigners" as to nationals of the country releasing the radionuclides. The IAEA is playing a major part in this effort.

A paper from the World Health Organization (WHO) served as a reminder that the magnitude of concern, knowledge, and complexity of approach that is being applied to radioactive waste disposal is much higher than that applied to other toxic wastes. The practical efforts required to put the radioactive waste management issue in the right perspective are not clear.

Prospects for international co-operation

In addition to presentations from various international organizations and of the results of international reviews of specific topics during the technical sessions, a panel composed of representatives from related international organizations and some Member States discussed the prospects for further international co-operation.

The chairman, Mr. E. Svenke, from the Swedish Nuclear Fuel Supply company, referred to what he called the "three dimensions of threat" from nuclear power - the "threat of nuclear weapons", the "threat of radion", and a "third dimension" characterized by the time-span during which radioactive wastes must be in final isolation. He concluded that international collaboration is not only valuable but in this field indispensable because of the "moral" dimension of the longterms safety requirements. These lead, without questioning today's national sovereignties and boundaries, at least to the need for international consensus on general principles and assessment methods. The potential usefulness of multi-national repositories was mentioned.

Representatives from the ICRP, IAEA, WHO, NEA, CEC and the Council for Mutual Economic Assistance (CMEA) described their fields of responsibility and activities; and this was followed by consideration of what countries such as France, India, Sweden, and the USA have experienced or could expect from international co-operation. In addition to general motivations for international co-operation such as the sharing of experience, obtaining economy of scale or the pooling of resources, there may be substantial influences on harmonization of national approaches or

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explaining their differences and getting socio-political and public acceptance. Several areas where international co-operation would be important were mentioned, but there was a consensus that the development of internationally agreed safety criteria, including methodologies and basic input data to demonstrate compliance with long-term safety requirements, should be a fundamental goal in order to show that safe disposal of all kinds of radioactive wastes is possible and that related designs and projects can be assessed and accepted for implementation.

The benefits from international co-operation are obvious. Given a broad international consensus on principles, and also on the safety assessment methods and input data, popular confidence that proper safety measures are taken can be built up.

There was also a recognition that the nuclear community might need more purposeful integration within society in general, and it was suggested that the IAEA as an international organization of high-standing could perhaps explore ways of communicating objectively with other professional and interested groups.

Radioactive waste management policy of India *

It was recognized quite early in India's nuclear programme that safe management of radioactive wastes is vital for its successful implementation. More than a decade before commissioning of the power reactors, emphasis was laid on studies relating to impact of radioactivity on the environment. The basic philosophy in the management of all radioactive wastes has been to concentrate and contain as much activity as possible and discharge to the environment only those streams that have activity concentrations far below the nationally and internationally accepted levels.

As a policy, management of radioactive wastes has been the responsibility of an independent unit which is answerable only to the health and safety authorities in meeting their requirements and not to the facility operator. This has led to the initiation of extensive research and development programmes with a view to ensure safety and self-reliance through maximum utilization of indigenous technological capabilities.

Over the years, the philosophy of radioactive waste discharge to environment has been continuously under review. This has resulted in adopting more and more stringent measures to minimize the release of radioactivity to the environment. These measures to minimize discharges from Indian nuclear facilities have been adopted not because of any adverse effects noticed in our environment, but in pursuance of our opinion that the ultimate goal of radioactive waste management should go beyond merely satisfying prevailing regulations.

Due to the vastness of the country, with widely varying environmental features at the different nuclear sites, it was required to evaluate the specific characteristics of each site and adopt norms for both discharge or radioactivity to the environment as also for containment of wastes that cannot be discharged. While the limits for discharge

of effluents at coastal locations like Tarapur and Kalpakkam take into account the significant dilution capacity available in the environment, the levels prescribed for hinterland sites like Rajasthan and Narora are, per force, more restrictive.

In principle, the Indian programme envisages two distinct modes of final disposition in respect of radioactive wastes; near-surface engineered extended storage for low- and intermediate-active wastes and deep geological disposal for high-level and alpha-bearing wastes. While other options like sea-dumping for low-active wastes and emplacement at medium depths below ground for intermediate-level wastes are being studied as possible options, our present strategy does not include these modes of disposal.

Economic considerations would warrant a large-capacity fuel reprocessing plant, centrally located, along with the required radioactive waste management capability. But in a largely populated, developing country like India, the logistical constraints, in terms of adequate transportation, network of suitable standards, and other infrastructural requirements, need to be reckoned with. As a result, at the present stage of the national development and priorities, we have found it more appropriate to set up smaller plants at different locations, notwithstanding certain economic penalties and the increased surveillance commitments. For the same reasons, it is necessary also to set up a vitrification plant for high-level wastes along with an engineered interim storage facility for the solidified waste products, colocated at each fuel reprocessing facility site. Only the ultimate disposal site for high-level wastes is presently conceived to be a centralized location.

Therefore, our policy can broadly be stated as follows:

- Any discharge of radioactive liquid or gaseous wastes to the environment should be as low as reasonably achievable, consistent with economic and societal factors.

- Low and intermediate-level solid wastes and solidified wastes resulting from conditioning of waste concentrates or liquid wastes generated due to operation of reactors and research laboratories, are to be emplaced in shallow land repositories, specifically constructed for the purpose.

- High-level and alpha-contaminated liquid wastes from fuel reprocessing facilities, which are initially stored in tanks, will be vitrified and the solidified products are to be stored on-site in near-surface engineered storage facilities, with appropriate cooling and surveillance provisions for a minimum period of twenty years.

- Disposal of high-level vitrified and cooled waste product and alpha wastes, will be in deep geological formations, specifically chosen for the purpose.

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In terms of the magnitude of the problem, the question of radioactive waste management does not warrant any concern at the present time in India. Though our current nuclear power generation is modest, considering the committed nuclear power programme by the turn of this century, it is necessary that our policy goals are framed from a long-term perspective. Our experience in managing low- and intermediate-level wastes has been good and it is expected that our present scheme for management of high-level wastes, which will be effective in the future, will also be a step forward in fulfilment of our objectives.

(Indian Journal of Power & River Valley Development, 34, 4(1984) pp.253-62)

Nuclear waste
Ocean disposal recommended

By Tim Beardsley

The US Government is being urged to consider ocean disposal for accumulating lowlevel radioactive wastes. In a special report to the President and Congress, the National Advisory Committee on Oceans and Atmosphere (NACOA) says it is concerned that "too little attention" is paid to the possible advantages of land disposal. The committee calls for more research to assess marine disposal options for ecological effects and pathways to man.

The United States has not dumped radioactive waste at sea since 1970, but other countries continued low-level disposal at various sites until a two year moratorium instituted under the London Dumping Convention in 1983. Despite strong political resistance to the practice, several nuclear nations are considering resuming dumping when the moratorium ends.

NACOA points out that the rate of production of low-level waste in the United States is likely to increase; the figure in 1980 was around 80,000 cubic metres. The US Navy has 100 operating nuclear submarines, and will be decommissioning between three and five per year, while several large commercial power reactors are nearing the end of their lives. NACOA belives that advances in marine science have made much less uncertain the environmental effects of ocean disposal, and urges Congress and the administration to reverse the present policy of excluding this option.

NACOA offers no detailed new study of environmental effects, but points out that all the anthropogenic radioactivity that has reached the oceans since 1944 is only one tenth of one per cent of the total natural radioactivity in the oceans. It raises the questions whether agreement can be reached on a level of anthropogenic radioactivity low enough to be ignored. The difficulty, acknowledged by NACOA, is that the national phobia about nuclear activities makes rational debate difficult.

The federal government and the nuclear power industry have, it says, limited credibility - "too often power reactors have proved to be less safe than advertised, and proposed waste disposal sites have shown more complex geology than originally suggested". NACOA calls on the Department of Energy to provide financial support to citizens' groups to initiate a public debate on radioactive waste disposal and restore confidence.

The Office of Science and Technology Policy at the White House is charged with initiating the new research effort, aimed at clarifying the effects of low-level waste disposal at sea. At present responsibilities are divided between several agencies, and NACOA wants to see a new inter-

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agency forum to examine the issues in detail. Investigations under way into the feasibility of sub-seabed emplacement of high-level waste might, it belives, shed light on low-level waste options. It also calls for an inventory of all anthropogenic radioactivity in the ocean; the International Atomic Energy Agency could undertake the task. In addition, US waste classification should conform with that of the agency.

According to NACOA's own estimates, the largest source of anthropogenic radioactivity in the ocean has been from weapons tests before 1968. Other major contributors have been lost submarines, plutonium-producing reactors and reprocessing plant. The list, however, is undoubtedly incomplete. NACOA bemoans the fact that much US dumping of low-level waste before 1970 was not adequately recorded, so that the opportunity to study carefully the effects of known dumps has been lost.

International agreement on dumping is highly desirable, it says, because the United States is not the only country contemplating a return to sea disposal, and its actions will be seen as setting a precedent.

(Nature, 310, 5976 (August 2, 1984) p. 354)

Sorting proteins at speed
By Staniforth Webb

A new technique developed at Harwell, the UK's largest laboratory, enables complex protein compounds to be separated from mixtures at the fast rates now needed in industrial biotechnology. Up to 29 protein fractions can be drawn off simultaneously.

Separating the constituents of mixtures comprising simple compounds, with small molecules, is a relatively simple matter. But chemists begin to run into problems when they try to analyse mixtures of complex protein compounds, with large molecules, which may differ only slightly from one another. Until recently, the techniques for doing this have usually had to operate on only a very small scale, separating compounds for research purposes at a rate of a few micrograms an hour. But things have changed with the vast growth in industrial biotechnology in the last few years. There is now a very rapidly growing demand for ways of separating and purifying complex proteins, on an industrial scale, from mixtures of many similar proteins.

Such techniques are needed, for example, to extract the products of genetically-engineered bacteria which have had human genes inserted into them, genes that instruct them to manufacture medically-valuable complex proteins such as interferon, insulin and human growth factor. And it is obvious that because compounds occurring in nature have a greater specificity of pharmaceutical effects, compared with conventional drugs, the use of such compounds in medicine is likely to grow rapidly.

Furthermore, it is probably safe to assume that when human-type proteins are produced by genetically-engineered bacteria, they will always be mixed with other complex proteins. So it is true to say that the progress of biotechnology, especially that part of it making use of recombinant DNA, largely depends upon techniques being found which can be used on an industrial scale for isolating and purifying individual proteins from mixtures of proteins.

Monoclonal Antibodies

One development of great value in this direction has been that of monoclonal antibodies. The technique was the brainchild of Dr. Cesar Milstein and Dr. George Kohler of the UK Medical Research Council's Laboratory of Molecular Biology at Cambridge. Monoclonal antibodies are made by injecting foreign substances, otherwise known as antigens, into mice and isolating cultures of cells from the spleens of the mice, which

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produce just the wanted antibody to a particular antigen and no other antibody. The cells are then fused with other cultures of cells that are growing vigorously. The resultant hybrid culture can then be grown to produce the wanted antibody indefinitely, in any amounts and in a very pure form.

Antibodies made in this way can then be used to purify proteins. Monoclonal antibody against a wanted protein can be attached to a surface over which a mixture containing the protein is passed. The protein becomes attached to the antibody and can later be removed from it.

This process is now being used to purify interferon, using an antibody and can later be removed from it.

This process is now being used to purify interferon, using an antibody which has been given the name anti-interferon, developed by the Cambridge laboratory and marketed commercially by the British bio-engineering firm Celltech.

The monoclonal antibody technique provides a means of purifying certain complex proteins on an industrial scale suitable for low-volume, high-value pharmaceutical products. It is, too, a way of producing the antibodies themselves. But it has inevitable limitations, particularly when the requirement is to separate several constituents from a mixture simultaneously. However, Dr. Christopher Lamb and his colleagues at Harwell, near Oxford, have developed a technique which is the perfect partner to the monoclonal antibody for purifying large amounts of proteins.

Electrophoresis

The idea developed by Dr Lamb in the Biochemistry Group at Harwell was to use continuous electrophoretic separation. The basic technique has been used very widely in research laboratories to separate small amounts, only a few micrograms per hour, but nobody has previously succeeded in scaling it up for industrial use.

The Harwell electrophoretic separator can produce pure proteins at a rate of 90 grams/hour, processing 2.4 litres/hour of mixture and drawing off up to 29 separate fractions simultaneously.

The basic principle of electrophoresis is simple (see Spectrum 126). A solution containing a mix of chemicals flows between two electrodes, one positively charged and one negatively charged. The different kind of molecules in solutions are pulled off in different directions according to their molecular weights and electrical charges, and are thereby separated from each other. This differential migration of molecules takes place in a gel when electrophoresis is employed in the

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laboratory to analyse mixtures, a technique that is in very wide use. The gel prevents convection currents being set up, which would cause swirling and remixing of the different molecules.

However, the gel technique cannot be used to separate proteins on a large scale because there are problems in extracting large quantities of pure material from the gel, so an alternative has been developed in which the mixture being separated is sandwiched between two plates in a very thin film, in a clear solution rather than a gel. The effect is to help prevent convection currents forming. This technique has been used to separate larger amounts than those which can be separated in gel electrophoresis, but they are still well below those required commercially.

In the separator developed by Dr Lamb, the mixture is pumped down a tube which is enclosed by an outer tube to form a vertical column about a metre high. It then passes up the space between the tubes. The inner tube is negatively charged and the outer one positively, so the differently-charged molecules separate as they flow up the space between them.

The speed at which the molecules travel towards the outer or inner tubes depends upon the magnitude of their charges. Those with the strongest negative charge move the most rapidly outwards, and those with the strongest positive charge move most rapidly inwards.

Viewed from above as they reach the top of the column, the differently charged proteins are separated into a number of clearlydefined concentric rings. Up to 29 different fractions can then be tapped off.

In this device, convection currents are prevented in two ways. The inner tube is stationary but the outer tube rotates at about 150 revs/minute, keeping the solution flowing smoothly. The solution is also chilled to about 2°C as it enters the column, to stop its temperature rising above 20° C during the unavoidable heating induced by the electric field. The speed of separation (the liquid takes only about 30 seconds to move from bottom to top) also helps to prevent convection currents.

The first important medical application for the separator is likely to be in separating Factor 8, a protein normally made in the human body, which is essential for normal blood clotting to stop bleeding. Factor 8 is missing or defective in haemophiliacs, so it

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has to be supplied to them. It is now being produced by biotechnology using genetically-engineered bacteria.

The Harwell system has also been shown to be effective in separating abnormal from normal red blood cells and for separating differently-charged isomers of certain compounds. Different constituents of cells, including enzymes and organelles, can also be effectively separated, as can mixtures of antibodies.

The separator is now being produced commercially by a private firm, CJB Developments of Portsmouth, under the trade name Biostream. One has already been exported to the USA.

(Spectrum, No. 187(1984) pp.15-16)

Malaria vaccine in sight?

The latest development in the molecular biology of malaria parasites is not so much a promise of prophylaxis as a sign that the promise will not foreever be postponed.

By John Maddox

What a day to meet. Thus Dr Adetokumbo Lucas, director of the World Health Organization's Special Programme for Research and Training in Tropical Diseases, brandishing one day last week photocopies of a set of page proofs of the articles in the current issue of Science (10 August) describing the structure of the gene for the principal antigen of the sporozoite form of human malaria, caused by the parasite Phasmodium falciparum. What Lucas meant was that since Nussenzweig and his associates at New York University last year described the structure of the corresponding antigen of monkey malaria (Nature 305, 29; 1983), everybody has been waiting for the other shoe to fall. And now it has.

As always, even the expected is surprising. Of the work now published, the more complete is that reported from the National Institute of Allergy and Infections Diseases, the National Cancer Institute and the Walter Reed Army Institute of Research in the United States (J.B. Dame et al., Science 225, 593; 1984), but the New York University (NYU) group (V. Enea et al., Science 225, 628; 1984) concurs in the chief finding - that the most conspicuous feature of the circumsporozoite (CS) protein from P. falciparum is along stretch in which a sequence of four amino acids is repeated end to end. Repetition on this pattern marks out the structure of the two CS molecules whose structure has previously been inferred (from nucleotide sequences) - those of P. Knowlesi and P. cynomolgi. But there the repeating units are respectively 12 and 11 amino acids long. That the repeating units in the antigenic coat of P. falciparum should be so short is one surpirse. There will now be a great rush to tell what can be said of the persumed repetitive amino acid sequences in other species of Plasmodium, causing malaria in people and animals.

As now described by Dame et al., the CS gene of P. falciparum is in three sections - a beginning, a middle and an end. The characteristic repeating section is the middle, which consists of no less than 41 four-codon repeats, corresponding to the amino acid sequence asparagine-alanine-asparagine-proline. But four of the 41 repeating units have a different structure, corresponding to the tetrapeptides asparagine-valine-aspartic acid-proline. In outline, the structure of the CS gene of P. knowlesi is similar but shorter, although the middle repeating unit is shorter, at 12 twelve-codon units.

The beginning and the end of both genes differ from the central repeating stretch in carrying codons that would specify hydrophobic amino acids. The downstream end is assumed to be anchored in the outer cell membrane of the malaria parasite. Perhaps in real life, individual malaria parasites are protected from the outside world by

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sheaths of protein molecules whose stability depends not only on the way in which the molecules are anchored in the membrane but also on their sideways interaction with each other. It remains to be seen whether the model-builders will justify their existence by offering an explanation of what the three different repetitive nucleotide units now defined for malaria parasites imply about the presumed common function of the corresponding amino acid sequences. It must also be significant, but of something as yet unknown, that the repeating gene sequence is preceded and followed, both in P. falciparum and P. knowlesi, by closely similar regions (15 and 12 amino acids long respectively) whose similarity suggests a structural function to be identified.

Evolutionists will also prick up their ears at these developments. The conventional wisdom is that parasites such as Plasmodium are so exquisitely adapted to their hosts - replicating at their expense without utterly destroying them - that their evolution must have gone hand in hand with at least that of the primates. One minor issue is partly answered by Dame et al.,: a gene with 42 four-codon repeats should be prone to instability in the sense that genetic recombination, insensitive as it is to anything but the chemistry of codons, will often decrease or increase the number of repetitive elements in a nucleotide sequence. But apart from the four odd units in the gene of P. falciparum described by Dame et al., there are also 19 regular repeating units in which different nucleotide sequences code for the same amino acid sequence. Recombination has its hands tied behind its back. The NYU group says that the strain of P. falciparum they have investigated has a stretch of 23 identical repeating units, but there is no room for such a structure in the gene that Dame et al. describe. So is it possible that the details of the fourfold repetition are strain-specific? This appears to be the case with the blood stage antigen (Coppel et al., Nature 306, 751; 1984).

Much will hang on the answer to that question (which should be easily obtained). The potential importance of the discoveries now described depends to a large extent on observations that quite small portions of the CS proteins, hardly more than a dozen amino acids, are antigenic. So the great hope evoked by this latest development is that it may be possible to make vaccines against malaria by synthesizing an appropriate polypeptide. The snag is that if interstrain variability is too flamboyant, the cocktail needed may be impossibly complicated. The immunogenic capacities of the nearly identical sequences before and after the repetitive sequences therefore cry out for study.

So how long will it be before there is a vaccine against malaria? The Lucases of this world know a trick question when they are asked one. The only proper answer, anyway, is "sometime in some future decade". Astonishing though it may seem, although malaria may be one of the best-described diseases, next to nothing is known, in modern language, of the mechanism of the details of the immune defence against it. Are antibodies, and the B-lymphocytes that secrete them, a sufficient defence against invasion by the sporozoites whose antigens are now

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described? How, artificially, will it be possible to give people a degree of protection against the infective form of the malaria parasite that will prevent lodgement in the liver? Is the cocktail-vaccine eventually needed bound to be one that caters not only for the antigenic variability of the invasive sporozoites but for the merozoites (matured in the liver) which eventually infect the red blood cells? And how, at the end of the cycle, can one prevent the maturation of the gametocytes from red blood cells, so breaking the cycle of infection via the mosquito?

Nobody knows. So we, but especially Dr Lucas, are in a cleft stick. In the endless battle against malaria, well-documented since Roman times and now said by the World Health Organization to be responsible for 150 million new cases a year (for want of an accurate number), we know that each new discovery may prove to be the basis for effective prophylaxis but with a chance of, say, one in 20. The work of Dame et al., supported by the Nussenzweigs, is one of those 20. Time will tell whether discovery will be crucial. But as a pointer to the questions that need next to be answered, its value is already clear.

(Nature, 310, 5978(16 August, 1984) p. 541)

Test-Tube Embryology in the Dock

By David Dickson

A special license should be required for all experiments involving the use of live human embryos, and any unlicensed research should be considered a criminal offense, according to a special committee of inquiry set up by the British government to look at the implications of recent developments in human fertilization and embryology.

The 16-member committee, which contained scientists, doctors, theologians, and laypeople, was chaired by philosopher Mary Warnock, Mistress of Girton College, Cambridge. The majority of its members rejected demands that have been made by different groups and individuals in Britain for a complete ban on all research using human embryos. However, the committee does suggest that such research should only be carried out within a strict legal framework. Each experiment would have to be justified and require a separate license; no experiment would be allowed on an embryo more than 14 days old (a point selected primarily because that is when the so-called primitive streak appears within the embryonic disk, which the committee describes as the first recognizable feature of the embryo proper); and any research carried out in defiance of such rules should be treated as a criminal offense

Such offenses would include keeping an embryo alive for more than 14 days, the unlicensed use of transspecies fertilization using human gametes, placing a human embryo in the uterus of another species for gestation, and the unauthorized sale or purchase of human gametes or embryos.

The Warnock Committee was set up by the British government in July 1982 to consider what policies and safeguards should be applied to recent and potential developments in medicine and science relating to human fertilization and embryology. It was largely prompted by the wide publicity given to the birth of the first "test-tube baby" but used the opportunity to examine a broad range of issues raised by surgical techniques, ranging from artificial insemination to surrogate motherhood.

The main thrust of its report is that, while none of these techniques should be prohibited, sufficient concerns exists about their implications to warrant strict regulations. In most cases, this would be done through a new statutory body, appointed by the government with broad lay participation, and with responsibility for licensing and monitoring both various types of fertility treatments (including that leading to test-tube babies) and research with human embryos.

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Evidence submitted to the committee revealed considerable reservations about the latter from the scientific community. The Royal Society, for example, wrote expressing its hope that "rigid legislative restrictions will not be imposed on the use of human germ cells and early embryos for research purposes."

It described as "unduly restrictive" a proposal from the U.K. Medical Research Council - broadly in line with that subsequently endorsed by the committee - that fertilized eggs should not be cultured in vitro beyond the implantation stage. And rather than setting up a new regulatory agency, the Royal Society suggested that the acceptability of particular experiments planned for various stages of the development of the embryo "is a question best handled by local ethical committees."

Furthermore, several scientists, focusing on the apparent arbitrariness of the 14-days restriction on research on live embryos, have claimed there would be a double standard involved in outlawing such research when Britain's abortion laws make it legal to terminate a pregnancy- and thus the life of a fetus - up to 168 days after fertilization.

However, the committee also heard from many others, particularly those representing religious groups, that fertilized eggs of any age should be treated as full human beings. The report itself claims the committee felt a duty to balance pragmatic and moral arguments, since "reason and sentiment are not opposed to each other in this field" and "there must be some barriers that are not to be crossed, some limits fixed."

Even so, its recommendations about where the barriers and limits should be placed were not endorsed unanimously by the committee's members. Three of the 16 signed a minority report suggesting that all experimentation on the human embryo be banned, and that the research for which scientists claim such embryos are necessary should be carried out by other means, for example, with animals.

Four other members dissented from the additional recommendations that scientists should be permitted to fertilize eggs merely for research purposes, rather than use only those created as the by-products of fertilization treatment. Their main argument was that it is immoral to create a potential human being when there is no intention or possibility of this potential being realized.

Another controversial suggestion made by the committee is that it should be made illegal for any agency or individual to arrange a surrogate pregancy - to find a woman prepared to bear the child of another woman unable, for medical or other reasons, to do so.

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Two members of the committee, dissenting from this conclusion, argued that forbidding the creation of any surrogacy agency - one of which already exists in England - would risk depriving some women of the potential afforded by modern surgical techniques of having their own children brought to term. They argued that effective regulation would minimize the potential legal, social, and psychological problems that might occur.

The rest of the Warnock committee, however, after an apparently lengthy debate in which it was finally felt that the hazards outweighed the benefits, decided to recommend that it should be made criminal offense to assist in the establishment of a surrogate preganancy. Furthermore, the committee adds that new laws should be introduced to confirm that "all surrogacy contracts are illegal contracts and therefore, unenforceable in the courts."

Other legal changes recommended by the Committee include:

When a child is born to a woman following donation of another's egg, the woman giving birth should, for all purposes, be considered as the mother of that child;

Any child who is born through artificial insemination by husband and who is not in utero at the death of its father, shall be disregarded for the purposes of succession to and inheritance from the latter.

(Science, 225, 4662 (10 August, 1984) p.606)

Biotechnology centres
Spanish self-consolation

By Pedro Puigdomenech

The Spanish Government is to set up a National Centre for Genetic Engineering and Biotechnology in Madrid.

The idea arose last year before the Madrid meeting of the Committee of the United Nations Industrial Development Organization (UNIDO) on the foundation and location of an international biotechnology centre. Officials from different ministries agreed to contribute funds from their respective budgets to support Spain's candidacy, but when the UNIDO committee decided to split the international centre between India and Italy, the commitment of the Spanish authorities to create a biotechnology centre in Madrid persisted.

A committee including government officials, industrialists and scientists has been at work for the past year, and a planning document has been approved and released. The committee has also approved the creation of a Centre for Microelectronics, to be split between Barcelona and Madrid.

The National Centre for Genetic Engineering and Biotechnology will have a staff of 220-260, including about 40 scientists. The initial group of scientists will come from laboratories already working in related areas, mainly in institutes of the Consejo Superior de Investigaciones Cientificas (CSIC, the Spanish science research council). Because of the lack of experience in some of the fields covered, other scientists will be recruited from elsewhere. It is likely that this and related projects will absorb many of the new positions to be created in CSIC.

The new centre will be housed in a 10,000m^2 building on the campus of the Autonomous University of Madrid, not far from the Centre for Molecular Biology, one of the leading Spanish research centres. The lines of research to be followed at the new centre will include molecular genetics, immunology, plant molecular biology, biochemical engineering and industrial microbiology. The total cost of the project is estimated at about 3,000 million pesetas (US$20 million) over the next three years.

The creation of the biotechnology centre is one outcome of the government's plan to concentrate research spending on a few priority fields.

(Nature, 310, 5978 (16 August, 1984) p.529)

Artificial fertilization
US Congress plans to act

By Tim Beardsley

A National commission to monitor the use of in vitro fertilization and related techniques in the United States moved a little closer last week . A house of Representatives subcommittee heard arguments for guidelines governing the practice from a wide range of legal, medical and ethical authorities, and the subcommittee's chairman, Representative Albert Gore (Democrat, Tennessee), has indicated that he will push for such a commission to be established under the National Institutes of Health (NIH) authorization bill.

Many of the witness at last week's hearings, held by the oversight and investigations subcommittee of the House Committee on Science and Technology, drew attention to the present chaotic state of laws impinging on in vitro fertilization (IVF). As IVF techniques are new enough to be considered still experimental, there could be legal challenges to some aspects of IVF in almost half of the states. Many states also have (inconsistent) laws that could affect embryo transfer, embryo freezing or commercial transactions involving gametes or embryos.

The House of Representatives NIH authorization bill, sponsored by Gore, includes a provision to establish a presidential commission on human genetic engineering. The Senate version of the NIH bill includes instead a provision to authorize Congress's Office of Technology Assessment to carry out studies in bioethics. Gore now believes that the scope of the proposed genetic engineering commission should be broadened to include matters related to new reproductive technologies, because the questions raised by the techniques are likely to be similar. This change of heart will make it easier for a compromise with the Senate version to be reached.

Aides are however anxious to point out that there remain substantial differences between the two versions. The House wants to see a very "visible" commission that would have lay and scientific representation, hold public meetings and publish annual reports. The Senate proposal for bioethics studies, in contrast, would leave the work very much under congressional control.

The two days of public hearings last week were enlivened by the unexpected appearance of group of mothers of children conceived through in vitro fertilization, some accompanied by their offspring. One of the mothers, Mrs Barbara Brooks, supported the calls for a presidential commission, arguing that it would in time make IVF techniques more widely available.

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Expe.c witnesses were almost unanimous in believing that the United has fallen behind in its thinking on IVF. A report on the subject prepared in 1979 by the Ethics Advisory Board of the Department of Health and Human Services has been left to gather dust, while the board itself has been disbanded. Federal funds cannot now be used to support research proposals have to be approved by the board to qualify for support, Researchers appearing before Gore's subcommittee last week argued strongly that a mechanism to allow federal funds to be used to IVF research should be reinstated.

None of the witness called last week argued against IVF itself, although many had reservations about the related freezing of embryos for future implantation or research. The questions of the rights that attach to an embryo, and whether an embryo can be owned, were seen by many as central to the debate. At one extreme, Professor John Robertson of the University of Texas argued that any restrictions on commercial transactions involving embryos or gametes could violate what he saw as the constitutional rights of couple to reproduce. At this Representative Gore appeared momentarily to forget his role as investigator, and started arguing the point.

On Thursday, attention turned to the technique for embryo transfer known as lavage, in which a fertilized egg is transferred from the uterus of a donor mother to the recipient. The practice was discouraged by the Warnock committee but is being practised in the United States by Professor John Buster, professor of obstetrics and gynaecology at Harbor UCLA Medical Center. The main controversy with lavage is however because Buster's commercial sponsors have applied for patent protection not only for the equipment and materials used, but also for the lavage procedure itself. A number of questions were asked last week about the propriety of patenting a reproductive technique.

(Nature, 310, (16 August, 1984) p.533)

Molecular cloning of a human DNA repair gene

By A. Westerveld *et al.*

(Abstract)

Cell strains derived from patients having a hereditary disorder associated with defects in repair of DNA damage such as xeroderma pigmentosum and mutants isolated from established rodent cell lines provide the tools for genetic and biochemical analysis of DNA repair pathways in mammalian cells. Complementation studies using these cells have illustrated the genetic and biochemical complexity of these pathways. The precise nature of the genes and gene products involved in these mutants has not yet been resolved. Isolation of repair genes by recombinant DNA technology would open up new approaches to the elucidation of repair mechanisms in mammalian cells. Here we report the molecular cloning of a human repair gene (ERCC1) that complements the repair defect in a Chinese hamster ovary (CHO) mutant cell line.

(Nature, 310, 5976, (2 August, 1984) p. 425)

Respiratory Hazards of Desert Environment

By M.L. Gupta et al.

Desert conditions of living are scattered all over the World except Europe and South Pole. The desert of Sahara in North Africa is the largest in the World. In India, the desert belt lies west of Aravali hills and covers 60% area of Rajasthan and some parts of adjoining States of Punjab and Haryana. As the respiratory membrane is the most extensive of all tissues that interface directly between man and his environment, it is worthwhile to review the possible impact of desert environment on it.

Pathogenesis :

The hazardous components of desert environment may be enumerated as follows:

1. Increased air velocity.
2. High temperature.
3. Decreased humidity.
4. Particulate materials:
   (a) Viable
   (b) Non-viable
   (c) Radioactive.

Increased air velocity and less turbulence help in propagation of particulate materials. It also helps in increased water loss. High temperature and decreased humidity in the environment is responsible for excessive water loss from the respiratory tract. This leads to feeling of soreness, dyspnea and increased incidence of upper respiratory tract infections but there is no evidence of any permanent damage to the respiratory membrane. Viable particulates including pollens, bacteria, fungi, moulds, spores or parts of insects such as hair, wings and legs are responsible for allergic asthama hay fever and various air borne fungal and bacterial diseases. Non-viable particulates injure the respiratory lining, lowering its resistance to infections. Air born dust often in form of sand storms is responsible for simple siliceous pneumoconiosis.

Respiratory disorders of Desert environment :

Besides the short term effects like soreness, breathlessness and increased incidence of upper respiratory tract infection, certain disorders are peculiar to desert environment. These may be classified as follows:

1. Simple siliceous pneumioconiosis.
2. Allergic disorders.
3. Infective disorders.

Simple siliceous pneumeoconiosis :

Simple siliceous pneumoconiosis is an asymptomatic pathological condition caused by deposition of siliceous dust in the lung in inhabitants of desert. Earlier cases were reported by Pollicard and Collect (1952) in Sahara and Farina and Gambini (1968) and Fossati (1969) in inhabitants of Lybian desert. Dust particles of less than 5 in diameter are deposited in alveoli. These particles are not fibrogenic in nature.

Pathogenesis :

Bir-Ziv and Goldberg (1974) classified silica dust into "old dust" and "new dust". The innocuous character of the old dust is due to transformation of fractured surface of dust particles or weathering. On the other hand dust particles of recent origin (new dust) are freshly tractured and are more noxious.

Pathology :

The silica particles may lie free in aloveolar space or in dust layden phagocytes (dust cell). These dust cells accumulate mainly around the bronchi and blood vessels but are also present in alveolar septa; subpleural region and lymphnodes.

Radiology :

The micro nodular densities are less than I mm in diameter and give an impression of reticulation. They are confined mainly to mid and lower lung fields. The advanced age of half of the patients and absenceof progression towards conglomerate formation points to the benign nature of simple siliceous pneumoconiosis (Hirsch et al 1974).

Treatment :

This condition does not cause any morbidity or mortality.

Allergic Disorders In Desert :

According to Under (1977) allergic disorders in desert differs on account of 3 reasons :-

1. A comparatively large variety of plants and obvious dryness of climate help in perennial pollination in desert. Elsewhere these plants pollinate only seasonally.

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2. There is a constant pollination from grass to which the inhabitants are exposed.

3. The type of trees in desert are different from those outside and it may take years of exposure for a person to become sensitive to a particular pollen.

Allergens Peculiar to Desert :

Palm trees are common but they affect only those who work or live in the groves. Olive is highly antigenic tree of chicogo desert but in mid west it is Ragwerd. Other weeds emit little pollen in air. Cotton woods are fairly comm in desert but willows and oak trees are not uncommon. Moulds and house dust allergens are uncommon in desert.

Infective Diseases :

Coccidioidomycosis :

South Western American Indian tribes living in dusty desert areas have high incidence of coccidiodomycosis. This is due to heavy infestotion of the soil with coccidioides immitis. A hot dry summer and dusty soil favour the growth of organism and might helps its transmission.

Hydatid Disease :

Hydatid disease is caused by a cestode called "Echinococcus granulosus. It is prevalent im nearly all parts of world but is more prevalent in desert areas of middle West, India, South America and Australia.

Though desert environment perse is not related to hydatid disease but ecological conditions favour sheep and camel husbandry. These animals are the intermediate host in the life cycle of echionococcus granulosus.

(Rajasthan Medical Journal, 22, 4(1983) pp.198-200)

Tumor and Tumor-like Hyperplasia Complication of Chronic Hepatitis and Their Traditional Chinese Treatment

By Shi Ji-zhao

(Abstract)

Based on the survey data of 1,512 hospital staff members and 34 chronic hepatitis patients the author notes increased tumor and tumor-like hyperplasia in patients with chronic hepatitis. Traditionally, early surgery is often advised for benign tumors to prevent malignant changes, but a serious hunt for concomitant hepatitis is not made. Therefore, whenever we come across a case of tumor or tumor-like hyperplasia, we should bear in mind the possibility of coexisting chronic hepatitis. A detailed history and through physical examination with varied liver function tests should be made. Sometimes even liver biopsy is needed. In this condition, we suggest using traditional Chinese medicine first, postponing consideration of surgery.

(Chinese Medical Journal, 96, 9(1983) pp.655-60)

Human Infection with Macracanthorhychus Hirudinaceus Causing Serious Complications in China

By Zhong Hui-lan et al.

(Abstract)

This paper deals with the parasitology, epidemiology, clinical manifestations, laboratory diagnosis, treatment, prevention and control of human infection with Macracanthorhychus hirudinaceus in China. The disease involves many provinces, and at times assuming epidemic proportions in certain areas. Obviously it is very much more prevalent than was previously known, especially in pigs. So far, this is the first finding occasioned by demonstrating both mature and immature eggs obtained through a fine needle from a mature female worm.

(Chinese Medical Journal, 96, 9(1983) pp. 661-668)

Epidemiological Patterns in Relation to Various Populations

By Muhammad Amin Sheikh et al.

(Summary)

Different factors, like natural calamities, living conditions, education, nutritional standards, feeding habits, contact with wild and domestic animals, age and sanitary conditions influence the epidemiology of various diseases in human population. This paper is designed to discuss in detail the manner in which these factors contribute to the spread of diseases. Recommendations are also made for minimising the chances of transmission of various disease problems in human beings.

(Pakistan Journal of Science, 33, 1-4(1981) pp.11-13)

Metabolism of Hepatic Lipids in Alloxan Diabetes

By U.P.S. Chauhan et al.

(Abstract)

Alloxan diabetes in rats caused 5-fold increase in the level of hepatic triglyceride. However, the levels of monoglyceride, phosphatides and cholesterol were marginally increased. In vivo incorporation of (U-^{14}C) glucose and 1-^{14}C) palmitic acid into hepatic lipids of normal control, diabetic and insulin-treated diabetic rats revealed preferential utilization of Sn glycerol-3-phosphate and fatty acids for the synthesis of triglyceride rather than for phosphatides. Quantitation of individual phosphatides indicated that the increase was restricted to lysophosphatidylcholine, phosphatidylcholine and phosphatidylethanolamine. In vivo incorporation of ^{32}Pi into phosphatidylcholine and lysophosphatidylcholine was increased suggesting increased turnover of hepatic phosphatidylcholine in diabetes. Insulin treatment to diabetic rats restored lipid metabolism almost to normal.

(Indian Journal of Experimental Biology, 22 (July 1984) pp.386-390)

Rural Energy Situation in China

By Zhong Guanglin

China's rural energy problem is very pressing. In 1979, the national consumption in the rural areas, if converted into standard coal, amounted to 350 million tonnes only, out of which 270 m.t. or 77% were locally produced biomass energy and most of it was used in the form of direct burning with heat efficiency as low as 5% - 10%.

Every year, about 400 m.t. of straw are burned; 300 m.t for cooking alone. In addition, 70 million of firewood are burned, which is approximately one-third of our annual timber output. Excessive deforestation causes soil erosion and desertification; the surface soil losses from cultivated land are about 5000 m.t. per year, and this equals 5 cm thick fertile soil on the good farmland of 2.6 million ha.

By the year 2000, the consumption demand of energy im rural areas for daily use will amount to 289 m.t. of coal, while for production use (not including the nergy for village industries) - 218 mtce.

Planning for Rural Energy Development

New and renewable sources of energy suit the very characteristics of rural areas : large population, scattered areas and lack of means of transportation. The emphasis in our recent development are:

1. Develop biomass production actively. In 10 years, we wish to develop 20 million biogas digesters which will meet one tenth of the daily energy consumption of the rural households.

2. Go in for afforestation in a big way; in 10 years we aim to supply one third firewood for the rural needs.

3. We plan to build mini-power stations capable of generating 12 million kW power, so as to meet the needs of agricultural production and/or rural consumption.

4. Popularize solar cookers and solar heaters in select areas,

5. Popularize firewood-saving and coal-saving stoves and raise the efficiency of burning fuels. By 1990, half the rural population will use such devices.

Present Status of Renewable Energy

Biomass is a major component of current Chinese energy. It constitutes more than one quarter of the total energy consumption of the country, i.e. equ. to 220 mtce By 1981, there were more than 6 million biogas plants in China. Biogas has become an integral part of the peasants' lives, since farm crops can usually be increased because of an

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additional use of organic fertilisers from biogas plants. The investment cost for a 10 m plant is around 70-100 yuan and such digesters produce 12 -2m gas day, providing the energy needed for cooking and lighting for a family of five.

By 2000 AD, 100 million biogas plants will be working, generating 60-80 mtce of energy, besides producing 100 m.t. organic fertilisers.

China has abundant solar energy; with a solar insolation of over 2000 hours per annum. Two thirds of China has total solar radiation over 140 kcal/cm/year. Solar heater is one of the major items - presently about 120,000 m solar collector area is in service. Plastic solar green houses are being used in vegetable plantation over 6000 ha. These facilities are both technologically and economically practical.

Small hydropower is abundant, with a capacity of 680,000 MW, of which 370,000 MW could by economically exploited. This forms only 3% of the total potential. Our policy is a combination of large, medium and small stations; nearly 90,000 small hydropower stations produce 6.8 million kW, i.e. 30% of the total electricity. More than 1500 out of 2000 countries in China have built up mini-hydrostations, thus covering 40% of agricultural electricity consumption.

Two windpower potential is about one billion kW. China was the first country to make use of wind energy. Nearly 200 windmills of different types have been set up and windmills of rotor type have been successfully produced on a trial basis.

Then there are around 2500 natural outcropping hot springs which offer great potential for geothermal energy.

Shale oil and peat form other potential resources. Present production of shale oil is 300,000 tonnes. Chine's peat deposits form about 3.5% of the world's total reserves.

Animal power is extensively used and looking to our geographical features and technical and economical conditions, it will continue to play an important role for a long period. Further development of animal power has its real significance in China.

(Bio-Energy Re-News, (February & April, 1984) pp.51-52)

Mining strategy for the nineties - coal developments in India

Coal mining has undergone dramatic developments throughout the world in recent years under the impact of energy shortages, and especially the escalating oil prices following the Yam Kippur war. A new vitality has emerged in this age-old industry, which has largely been a technological laggard. The scenario for Indian coal industry, since nationalisation in 1971 and 1973, has matched closely the global pattern and there has been a veritable leap forward in coal production. Keeping in view the ambitious targets of production, and presuming that the demand projections would not go awry, it is necessary that we take a close look at new technological developments and their possible adoption in the coal industry. The prospects for coal appear to extend far into the future and decisions made now will influence the industry's future for a long time to come.

The availability of large reserves of coal under shallow depths of cover, estimated to be of the order of 30,000 million tonnes constituting some 27.7 per cent of the total reserves down to 600 metres depth, coupled with the low gestation lag and potential for very high recovery, have largely dictated the focus of interest in surface mining methods. This trend, which is already visible in surface mine production, will be the mainstay of increased coal production in future years and, hopefully, by the turn of the century will contribute to some 60 per cent of the national output. A mix of technologies are being adopted and adapted in surface mining to cater to the increased volume of production and the coal industry is set fair to a major developmental effort in surface mining.

In the underground mining scene, however, the planning decisions appear to be in a state of flux and major decisions on the selection of equipment or of mining systems are amiss. While longwall mining is expected to have an increasing share of the underground coal production, the applications thus far have been hesitant and halting and the barbier to longwall application is yet to be surmounted. Currently, longwall coal production contributes to less than 3 per cent of the underground output and there are only some 5 mechanised powered support faces in operation. In terms of the industry's needs, the pace of application has been far too slow and the decision dilemma, whether to use advanced technology mining systems or the conventional mechanised longwall faces or to use individual props, seems unresolved. In the bord and pillar mining area, mechanisation has taken roots far too slowly. There have been some half-hearted attempts at the introduction of mechanised loading and of LHDs; mining by a fully mechanised bord

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and pillar system using continuous miners is still on paper. Since the planning of new underground mines extend over a period of many years, during which decisions are made concerning the production strategy, the choice of the most suitable equipment complement is a vital factor on the production and productivity levels to be attained. Decisions once made cannot be readily retraced, leading to infructuous investment of a very high order.

If the production plans are to be fulfilled in the next decade, the choice of appropriate production strategy and equipment must merit careful consideration of a mining method, compatibility with the geo-mining conditions, reliability, efficiency and productivity. The over-riding thrust on surface mining has in the recent past led to a neglect of the all-too-vital underground mining sector where the planning decisions are far more complex. Likewise, the strategy of underground mining of thick seams is yet another vital area for which appropriate and cost-effective solutions have to be sought. The coal industry's future well-being will hinge largely upon decisions and appropriate policy actions on the mining trategy for the next decade.

(Journal of Mines, Metals & Fuels, 32, 4-5 (April-May 1984) p.163)

Artificial Photosynthesis as the Key to Man's Survival

By Kenichi Honda

All living systems on earth have depended on the natural process of photosynthesis for hundreds of millions of years. Moreover, with the rise of the natural sciences in modern times, scientists have looked to photosynthesis for their studies. Thus, research on photosynthesis has a history as long as the development of the natural sciences.

The scope of present photosynthesis research, which has been attracting attention worldwide, is much broader than that of previous research conducted in a purely scientific manner. In other words, photosynthesis now denotes the synthesis of new materials through light energy. Although photosynthesis had been defined conventionally as a process conducted by plants, present research on photosynthesis includes the synthesis of oil and foods through the utilization of sunlight and the conversion into electricity.

The efficiency of photosynthesis differs greatly according to the type of plant. For example, photosynthesis is performed very efficiently in corn, rubber trees, giant seaweed and South American taro plants, Thus, efforts to increase the harvest of agricultural products by cultivating these highly efficient plants are also part of present photosynthesis research.

Another area of photosynthesis research is concerned with simulating the functions performed in living plants, such as by creating artificial or synthetic leaves. Artificial leaves are experimentally available, but have not yet been commercialized or manufactured.

As in natural photosynthesis, water and air are important raw materials in artificial photosynthesis for the production of carbohydrates such as starch, glucose and cellulose. Carbon, hydrogen and oxygen are the three elements that make up these complex compounds as well as oil, rice, potato, beans and leaves. Thus, one of the major objectives of photosynthesis research is to synthesize the essential building blocks of life from the above three elements.

In plants, chlorophyll plays a central role in photosynthesis. Researchers thus thought first of utilizing natural chlorophyll in designing an artificial photosynthetic device. High-quality chlorophyll can be easily extracted from Chinese cabbage and spinach.

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The wholesale use of natural chlorophyll, however, prevents the photosynthetic system from being completely artificial. For example, at present, chlorophyll is used for the synthesis of hydrogen. The extracted chlorophyll molecules are rearranged on a plate and exposed to light, which creates an electrical current. Hydrogen is generated through the interaction of this current with water.

Carbon is obtained by reducing CO_2 from the atmosphere with the electrical current mentioned above. The carbon is used to produce formic acid, methanol, methane and other basic materials for starch, cellulose and glucose. This process involves, first, extracting the carbon atom from the CO_2 molecule to produce methane (CH_4); the addition of another carbon atom yields either ethane (CH_3CH_3) or alcohol. By successively increasing the number of carbon atoms to five or six, foods for humans can be produced.

The next objective is to realize a perfect artificial photosynthesis process by creating artificial chlorophyll. Already there have been many experiments that achieve photosynthesis by using materials that are easily obtained and more simple in structure than chlorophyll. For example, metal compounds such as phthalocyanine, porphyrin and ruthenium are used as substitutes for chlorophyll.

The utilization of semiconductors follows as a later step. Although semiconductor technologies have already achieved remarkable progress, they have been adapted for use only as electronic devices. Now, deliberations on semiconductor applications are being conducted from a different angle, on whether or not semiconductors can be utilized for food-producing photosynthesis. Semiconductors make possible the extraction of hydrogen from water - an abundant resource on earth.

Although numerous individuals have been engaged in research on photosynthesis, the level of research is still at the basic stage and too immature for practical use or industrialization. One reason is the availability of oil, which produces much cheaper energy than that which can be obtained by photosynthesis at this time.

Promising Solution to The Energy Problem

The two oil crises in the 1970's drew world attention to the energy problem, and revealed that the availability of oil will pose a more serious problem within the next 50-100 years. With its potential for producing artificial oil, photosynthesis research has thus come under focus as a promising means to help solve the energy problem.

Plants decompose, after missions of years, into the fossil fuels coal and oil. Animals too, which consume these plants, eventually turn into fossil fuels. Thus, light energy for synthesizing carbohydrates can be regarded as the origin of all life.

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As mentioned above, present economic and industrial systems are based on the consumption of oil. Although the use of alternative non-oil energy sources is still relatively expensive. It is important that photosynthesis research be conducted as a long-term effort to prepare for the eventual depletion on natural oil reserves.

Photosynthesis and Ecology

Photosynthesis research is indispensable also for the solution of ecological problems. It is already well-known that the concentration of CO_2 in the atmosphere has been increasing, primarily as a result of the excessive combustion of oil. If the present rate of oil consumption continues, man will have depleted oil reserves created over the course of a billion years, within a mere span of 200 to 300 years.

The rising levels of CO_2 in the atmosphere pose a serious environmental problem. One of the objectives of photosynthesis research is to reduce this threat by absorbing excess atmospheric CO_2. Unless this is achieved, the continued existence of life on earth cannot be assured.

Plants absorb carbon dioxide from the atmosphere, and release oxygen. All other living creatures inhale oxygen and exhale carbon dioxide. This natural carbon cycle is threatened by man's heavy combustion of oil over the last few decades. Photosynthesis research provides the only hope for reversal of this alarming trend.

Crucial as a Future Industry

Unless photosynthesis is established as an industry for the 21st century, it is feared that the progress of civilization will come up against an insurmountable wall. An adequate supply of food and energy is the basic requirement for the survival of the already excessive world population. Because the natural production of food and energy will inevitably reach a rigid limit of returns, man must establish an industry for artificial production to ensure his existence on earth.

The nature of such an industry will be that of a chemical industry. Other existing industries do not concern the production of substitutes for essential materials. For example, the steel industry produces different types of steel for the construction of buildings or bridges, but could not exist without the availability of iron ore. By contrast, a chemical industry would try to produce steel when iron ore reserves are depleted. Similarly, a chemical industry would try to achieve the artificial synthesis of foods and fossil fuels in the face of exhausted natural production. Such an enterprise could be regarded as the next-generation chemical industry - food-synthesis and oil-synthesis through the utilization of sunlight.

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The realization of this type of chemical industry is related to progress in research on nuclear fusion. Once achieved, nuclear fusion will supply extremely cheap energy, a valuable asset for synthetic chemical production. Energy from nuclear fusion may also be used in place of sunlight for artificial photosynthesis. However, this development will probably not become a reality for many years to come.

It is difficult to estimate when synthetic fuels will be commercialized, or how much of a share they will occupy in the total energy supply of the future especially when there is presently no consensus on when the earth's oil reserves may be depleted.

The industrialization of photosynthesis should be conducted as a long-term project extending until the middle of the 21st century. If the technological foundation for artificial photosynthesis can be established by the year 2050, we will be able to cope with the exhaustion of oil reserves, worldwide climatic, changes, and continuous poor harvests. Man will then be able to pursue an expanding horizon for his civilizations.

(Look Japan, (June 10, 1984) pp.18-19)

Some Field and Laboratory Data from an Oil Spill in Northern Norway During April 1982

By Inger-Britt Falk-Petersen et al.

(Abstract)

Moderate amounts of oil came ashore in Troms county, northern Norway, in April 1982. Most of the oil was deposited in the supralittoral zone and ecological damage was slight. Toxicity tests with sea-urchin eggs and cod eggs and larvae showed seawater extracts of the 'fresh' stranded oil to be quite toxic; effects were noted at concentrations below 1 mg/l. After 5 months on the beach weathering had polymerized the oil extensively and further reduced its water solubility, but the viscosity had not changed appreciably. After 12 months the oil contained very small amounts of n-alkanes and volatile oxidation products, but the viscosity and water solubility had not changed much.

Seawater extracts of the oil samples collected 5 and 12 months after the spill did not give any direct effects during 4 days treatment of sea-urchin and cod eggs, but during the further development of the cod, effects were observed during hatching in hydrocarbon concentrations around 1 mg/l.

(Sarsia, 68, 4 (1983) p. 263)

Ecological and Regional Zoogeography of the Marine Benthic Fauna of Chile
Report No. 49 of the Lund University Chile Expedition 1948-49

By Hans Brattstrom and Arild Johanssen

(Abstract)

The zoogeographic analysis is based on 240 species of 13 taxa, mainly the many new records from the 'Lund University Chile Expedition 1948-49'. The purpose has been to find out whether or not the new data confirm earlier conceptions of zoogeographic regions and borders in Chilean waters. The climatic conditions at the shore and the hydrography are described. The Chilean archipelago differs from the area north thereof both in topography, climate, and hydrography. The direction and extension of the currents and the small differences in salinity and also in temperature along the shore favour a wide distribution. Except for brackish-water areas in the archipelago the salinity is high. The sea off Chile is colder than at the same latitudes in other oceans, except for southern Chile, where the sea is a little warmer than normal. The local annual range in temperature is small.

The vertical and horizontal distributions of the species are illustrated in tables and maps. There are few wide-spread and endemic species among those treated. Northern species dominate in the littoral and in shallow water, southern in deeper water, but the fauna in its entirely has a northern stamp. Northern species also have a wide distribution in Chilean waters than the southern ones. The changes in taxonomic composition with depth and latitude are described. The maps show a ste-like distribution pattern. One step, at the northern end of Chiloe and in Seno Reloncavi, about 42° S, Seems to be real. There 60 of the 219 non-widespread species have their southern or northern limit. The other steps are most likely only apparent, being the result of more intense investigations in the areas where the steps are found than in the areas in between.

The results confirm those of earlier investigations. There are two temperate region. The border is found at about 42° S and coincides with the change there in topography and partly in climate and hydrography. Within the warm-temperate region there is a transitional area between 30(33) and 42(46)° S, in which many species from both regions coexist.

(Sarsia, 68, 4(1983) pp.289)

Empirical approach to estimating the composition of the continental crust

By Barry L. Weaver and John Tarney

(Abstract)

The continental crust has ultimately been extracted from the mantle and knowledge of its composition is therefore fundamental to an understanding of the chemical evolution of the Earth. Attempts to model its average chemistry are complicated by marked vertical and lateral chemical and lithological heterogeneity and by problems of sampling the deeper levels of the crust. We have adopted a different, empirical, approach to try and take account of geophysical and isotopic constraints by considering the major and trace element chemistry of components which are typical of various crustal levels and ages. Our estimate differs from that of the 'andesitic' model in being more siliceous and having a more fractionated rare earch element pattern. Its higher Th, U and K contents generate a higher heat production of 0.95 μ Wm^{-3} compared with previous estimates of 0.75- 0.91 μ W m^{-3}.

(Nature, 310, 5978 (16 August, 1984) p.525)

A New Hope in Eco-Technology
Need to Reconsider Technological Objectives

By Shuhei Aida

Eco-technology is a new field of engineering which aims for a symbiosis of technology and ecology by bringing a new scientific perspective to an eternal dilemma for modern civilization - how to promote technological progress while preserving the natural environment.

Those of us who have inherited the traditional scientific perspective originating with Galileo Galilei (A.D. 1564-1642) must now revise our thinking, especially amid the current spurt of technological innovations, on the development and application of technology. In particular, it is important for Japan, as the only advanced industrialized nation possessing the spirit of the Orient, to take up eco-technology as a new philosophy for technology in the present era of diversified values.

Originating as the study of vegetation in the 19th century, ecology has grown into the study of the global ecosystem and all living things, including human beings. Under the new discipline of eco-science, ecology has branched into issues concerning culture and economics. The concept of ecotopia, which considers ecology as being incompatible with modern civilization and progress, emerged in the U.S. along this trend. The common thread underlying these recent developments in ecology is the recognition that we must reconsider conventional objectives developed by Galileo for modern technology.

Ongoing Revision of Scientific "Truths"

The necessity to revise traditional perspectives is frequently seen in the history of science. Many concepts that were considered inviolable in the days of Aristoteles (B.C. 384-322) have been proven wrong by modern scientific reasoning. For example, people in ancient Greece constructed the false argument that an object is heavy because it drops, not that an object drops because it is heavy. Accordingly, they believed that the heavier the object, the faster it would drop. It was inevitable that the radical revision of such scientific fallacies would bring about much shock and confusion in medieval Europe.

It is not an exaggeration to say that a similar shock has begun to emerge in modern science. Scientific progress is radically altering existing definitions and values. For instance, the development of astronomy and molecular biology has changed man's conceptions of size, such that an object's physical size is viewed separately from the magnitude

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of its influence or significance. Though governed by laws of nature, dynamic relations in the universe can now be measured and calculated fairly quickly by computers. This implies that the universe, despite its infinite size, can be manipulated by man since its basic structure is already understood. In contrast, the field of genetic engineering, which deals with a microscopic world, exerts a far-reaching influence over mankind. Such disparity between the physical magnitude and the qualitative value of technological development is widening further by the recent progress in science and technology.

Associating the Specific With the Universal

Similarly, our perception of nature and ecology is changing as a reflection of the times. The "dissipative structure theory" postulated by the Belgium Nobel Prize winner, Professor I. Prigogine, is based on these ideas. By utilizing theories of physics and chemistry, Prigogine concludes that the nature of the universe arises not from deterministics, but from stochastics.

For example, although we use the law of motion dynamics to explain the occasions when we observe a beautiful moon, the moon's beauty remains impressive even when it is obscured by clouds. Our subjective observations of the moon are based on probability, not on physical determinism. This and other related issues are included in the scope of eco-technology.

Eco-technology also combines an analytical atomist perspective with a comprehensive holistic outlook in an attempt to grasp the fundamental truth of life. For example, eco-technologists are currently studying the nature of technological transfer and the influence of automation technology on individuals, society and culture.

In this sense, the ideas of eco-technology are extremely valuable for an increasingly interdependent modern civilization. Galileo's words that "there is no stronger force in the universe than the force which controls the self," still hold true today, and have formed the crucial starting point for eco-technology.

(Look Japan, (April 10, 1984) p.28)

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